OPERATIONAL COMMUNICATIONS: WHAT DOES IT TAKE?

A Monograph
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ABSTRACT

OPERATIONAL COMMUNICATIONS: WHAT DOES IT TAKE?

by Major Ralph I. Ebener, Jr., USA, 65 pages.

This monograph determines what is needed to allow a corps signal brigade to provide operational communications in support of modern joint operations. It focuses on the corps signal brigade in Europe because of the potential for that corps commander to act as a Joint Task Force (JTF) commander in combat or non-combat operations, within the greater European theater. Since his signal brigade is primarily oriented on tactical operations, it is reasonable to surmise that additional assets may be required to support operational warfighting requirements, which include communications links to naval and air component commands.

The monograph first addresses distinctions between tactical and strategic communications with roots in the birth of the Signal Corps in the Civil War, when miltary and commercial interests vied for the distinction of providing telegraph service to the military. The monograph then traces the development of the signal organizations that provided operational support to corps from the 1860s to the 1960s. This grew from a tactical telegraph company to a large battalion by the end of Vietnam, and became a brigade in the 1980s as requirements for communications support continued to grow.

The monograph next discusses modern operational communications as provided in the recent Operations Desert Shield / Storm and Uphold Democracy. These actions required synchronized joint and combined operations, and can be characterized by the number of diverse communications organizations and assets brought together to perform. In neither case did the conventional corps signal brigade possess enough long-range transmission or data or voice switching assets to accomplish the mission. The monoograph details those assets and capabilities that were required.

The monograph concludes that a composite organization, comprising assets common to corps signal brigades and theater signal brigades, may provide enhanced support to the Army corps commander when acting as an operational JTF commander. It then recommends certain steps toward that goal.

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Introduction

To control many is the same as to control few. This is a matter of formations and signals--Sun Tzu[1]

Sun Tzu's words resonate today. His concern with formations and signals translates for the modern military into issues of organizations and technology. In the current environment of downsizing and budget-cutting, maintaining control forces a tradeoff in affordability between size and type of organization and quality, type and generation of technology to adopt. Such decisions can have long-range impact. Significant improvements in organizational structure or technological developments have provided decisive advantages to various nations throughout history.[2] From social theorists like Alvin and Heidi Toffler to military leaders like General Gordon Sullivan, Chief of Staff of the Army, much current thought suggests that future warfare may be decided in favor of the side that best manages information. As Commander James Hazlett and Martin Libicki put it:

> "Technology, used correctly, begets doctrine; doctrine begets organization. To the extent that tomorrow's military power is defined by expertise at information rather than the application of force, military superiority may flow to those organized for the former task rather than the latter one."[3]

Some posit that digitization is the technological silver bullet that will allow the U. S. Army to maintain "information dominance" in "Third Wave" warfare. Digitization is an admirable objective; but, digitization alone may not suffice. The many studies and concepts announcing Force XXI and notional visions of digital divisions do not yet possess the force of doctrine. Still, it may

prove useful to consider possible changes in organizational structure to posture the Army to take best advantage of digitized information. Organizing today to exploit the digital technology explosion could be the key to success tomorrow.[4]

Digitization is a technique for transforming information into bit streams for ease and rapidity of transmission, storage and manipulation. It leverages the modern technological development of the digital computer's microprocessor. Once digitized, information must find adequate and available paths to follow to reach decisionmakers in a timely fashion and in useful form. The Signal Corps has been responsible for providing access to communications links and networks for the transmission of information since its inception. This remains true today. Requirements for information have literally exploded in recent years. Providing adequate "pipes" for information on the "digitized" battlefield stresses the capabilities of current Army Signal Corps units.[5]

Since the beginning of the Signal Corps in the Civil War, there have always been significant differences between tactical communications (supporting maneuver forces directly) and strategic communications (connecting senior headquarters with sustaining base and national command and control systems). Mobility and capacity have been the predominant distinguishing characteristics. Tactical communications equipment tends to be lightweight, mobile and low capacity. Strategic communications resources tend to be large, relatively immobile and of high capacity. Rarely could equipment common to a strategic communications unit function optimally in a tactical environment, and, likewise, tactical gear would be inadequate to strategic purpose.[6]

The organizations that provide communications service also became stratified during this period. In a situation analogous to that between American Telephone and Telegraph (AT&T) and the Bell Telephone companies, tactical and strategic communicators had different constituents and developed completely different corporate cultures. To this day, there is no one voice speaking for the Signal Corps. The U.S. Army Information Systems Command (USAISC) and the U.S. Army Signal Center and Fort Gordon (USASC&FG, or SigCen) vie for pre-eminence on communications issues, with the former having proponency at the strategic level while the latter focuses on the tactical level. This division is counter-productive in an era of "foxhole to White House" connectivity.[7]

Infrastructure also plays a role in dividing tactical from strategic. Bridges or connecting gateways between tactical and strategic communications systems have functioned as chokepoints and vulnerabilities rife with interface problems. While standardization has been served by systems such as Mobile Subscriber Equipment (MSE), at least within the tactical echelon (corps and below), standards for "information systems" have not been implemented across the full spectrum. Without common standards and protocols, the flow of information from the tactical environment into the strategic echelons has been frequently impeded.[8]

Change, however, is imminent. Practical distinctions between tactical and strategic communications systems may be diminishing gradually in importance. The commercial world offers apt examples. Companies like Sprint are offering subscriber service packages tailored to provide the user with any combination of

local, long-distance and cellular telephone access, along with cable television and video-teleconferencing and home-office functions. Communications satellites, functioning as space-based relays, have greatly extended the range of individual communications links. Fiber optics provide much larger transmission bandwidth, greatly increasing circuit or channel capacity.[9]

The Army has seen similar beneficial developments. Increasingly, new weapons systems possess embedded and integrated communications systems. User or owner-operated communications equipment has become the norm at the unit level, with Signal Corps organizations providing access to local or wider area networks and "backbone" transmission systems intra-and inter-theater. Information technology provides leaps in capability every few years, and "each successive generation is both faster but cheaper, smaller, and less power-hungry as well."[10] Given the continuation of that trend, it is possible that a telephone switching assemblage that might once have required a building and power plant to house may be transportable on a soldier's back. Modern tactical equipment may have as much capacity or capability as strategic communications gear. Digitized information knows no distinctions between levels of war; it looks only for an open path and a receiving station.[11]

This study focuses on communications support for the operational warfighter who, by definition, must link strategic aims with tactical employment of forces on the battlefield.[12] Increasingly, headquarters traditionally considered tactical (corps and below) may be called upon to conduct operational-level warfare, implying combination with joint-service or coalition forces.[13] As the

Army's doctrinal Field Manual (FM) 100-5, Operations, states: "A corps commander might command . . . a Joint Task Force (JTF)."[14] Yet tactical signal units, such as corps signal brigades, may not have the organic communications equipment or personnel necessary to support a corps headquarters functioning as a JTF. When a JTF deploys on a mission, the organic signal unit supporting the Army component is usually augmented with assets from a theater level signal unit, supplemented with satellite communications or troposcatter transmission equipment and, occasionally, advised and assisted with joint interoperability issues and technical expertise by elements of the Joint Communications Support Element (JCSE). So, tactical communications units can rarely meet operational Joint warfighting requirements without augmentation.[15]

The Army's FM 100-16, Army Operational Support, defines the operational level signal organization functioning "under the USAISC and under Operational Control (OPCON) of the Army Service Component Commander (ASCC)." This organization "provides voice and data *tactical* information services to the theater of operations." It also provides "out of theater access and connectivity to other joint and multi-national elements." This suggests two things: one, that operational level signal units exist, and; two, that these units provide tactical service (in addition to the tactical signal unit that will be supporting the maneuver headquarters) as well as capability that could be considered strategic in scope, thus, like operational warfare, linking tactical systems with strategic resources.[16]

While FM 100-16 does not specify these operational signal organizations by number or unit designation, it refers to "theater-tactical" signal units such as the 11th Signal Brigade from USAISC at Ft. Huachuca, Arizona and the 7th Signal Brigade, under 5th Signal Command (also under USAISC) in Germany. A third unit that defines itself as tactical because of its mobility and focus on contingency operations, but possesses high-capacity, long-range and jointly-interoperable communications assets is the JCSE. This study will describe more of the role and capabilities of these units later, but it will suffice for now to say that they possess assets that uniquely qualify them to provide operational communications support.[17]

Fundamentally, the Signal Corps is not organized to support joint warfighting requirements. While task organization is the norm, and versatility a tenet of the U.S. Army, it seems reasonable and timely to investigate whether communications organizations could be tailored better to meet joint operational warfighting requirements. This study looks at the army corps to determine if the corps signal brigade structure provides adequate capability for the corps headquarters to operate as a JTF headquarters. It advances the thesis that a "composite" organization may provide a better organizational structure to support a JTF than the current, MSE-equipped corps signal brigade.

Instead of looking at each or all of the Army's corps, this monograph looks at Europe where the U.S. still has V Corps, and its organic 22nd Signal Brigade, stationed as a forward presence in Germany. Though it seems obvious enough that V Corps will not soon be fighting Russian tanks on the plains of central

Europe, it is equally clear that significant regional unrest still exists. The North Atlantic Treaty Organization's (NATO) current paralysis in effecting a peaceful resolution in Bosnia-Hercegovina has not kept the planners at U. S. Army, Europe (USAREUR) or U. S. European Command (USEUCOM) from developing contingency plans that include potential tasks for V Corps to function as a JTF headquarters.[18] To remind the reader of recent precedent, VII Corps deployed from Germany in 1990 to the U.S. Central Command (USCENTCOM) theater of operations to form the powerful "armored fist" in Operation Desert Storm. Despite a similar previous focus, V Corps could someday find itself in Bosnia, Crete, or southeastern Turkey.[19]

In summary, this monograph considers whether a composite signal organization, comprising assets common to corps and theater signal brigades, may provide enhanced support to the operational army corps based in Germany which may function as a JTF. The issue is complicated by the fact that no two corps signal brigades are identical: indeed, the corps they support are far from similar. So, the conclusions drawn here may not be applicable in specifics to other units; but, the analysis and recommendations may have broader validity than to the necessarily narrow scope of this study.

Background: Development of the U.S. Army Corps Signal Brigade

"There is an old Army maxim: 'The communicators are the first ones in, and the last ones out.'"--MG Thomas M. Rienzi, 1971[20]

Birth of the Signal Corps: The Civil War

The U.S. Army Signal Corps was born just before the Civil War. The signaling flag system (known as wigwag) developed by an Army surgeon, Alfred J. Myer, used two flags in the first manifestation of "digital" command and control. A congressional act on 21 June 1860 provided for the "appointment of one signal officer at the rank of major and $2,000 for signaling equipment. Unfortunately, in the subsequent war both sides implemented similar systems, as one of Myer's assistants soon found himself working for the Confederacy, so this development provided no decisive edge to either side.[21]

Operational communications also debuted in the Civil War. The telegraph significantly improved communications transmission speed and range and, hence, command and control, by its ability, coupled with long-distance railroad lines, to transmit messages rapidly over relatively long distances. Some military theorists propose, in fact, that operational art, or the ability to prosecute operational warfare, was enabled by these enhancements to the movement of troops, supplies and information.[22]

Less often mentioned, though well known, is the signaling means employed by this system. Messages, or telegrams, were transmitted in a simple digital code, invented by S. F. B Morse in the 1830s, and known even today as Morse code.[23] This combination of dots and dashes was actually the first

"digitized" communications system; the operators at either end were in essence the first digital computers with modulator / demodulators. This either / or dichotomy (or on / off for electrical circuits, or 1 / 0 for modern computers) represents the most unambiguous method of encoding information, and remains today the essential technique.

A shortcoming of these means grew from the decision to develop two separate telegraph capabilities, one "tactical" and the other "strategic". In the Civil War, different firms vied for the contractual rights to transmit information for the War Department. A Western Union official, Anton Stager, led the Military Telegraph Company which provided the strategic connectivity for early Civil War campaigns for the Union. His organization owed obligation first and foremost to its primary consumer, the railroads, and provided military service only to major railheads or cities for its War Department client, which nevertheless found it of great utility in sending orders to field armies.[24] Myer, on the other hand, was busy building and training a fledgling Signal Corps in his visual signaling system, which by 1863 could transmit three words per minute ten miles between stations.[25]

Myer had initially thought his visual system would be adequate, but the commercial innovation of the telegraph had gained favor with the Washington bureaucracy. He had to adapt and set about creating a tactical telegraph. Myer developed "trains" of tactical signalmen who strung telegraph lines on 17 foot tall lances from wagons drawn by mules or horses. One wagon carried the heavy batteries required for portable power for the new Beardslee magneto-electric

telegraph machine and formed the central office. Four wagons carried wire and four carried the lances. Six officers and about 175 enlisted soldiers provided the personnel complement, or about the equivalent of a signal company today.[26]

By 1863, the Signal Corps operated 30 telegraph trains, or roughly one per corps in the field. Each train could string about 50 miles of wire on four separate lines to connect the corps headquarters with its subordinate divisions. Couriers and flags were still used at smaller unit level (and when not near rail lines or stations), but electrical telegraphy caused the waning of the wigwag. Myer's subsequent attempt to consolidate control of all military telegraph assets led to his temporary removal as Chief Signal Officer.[27]

Unfortunately, these early tactical telegraph communications were not very reliable or responsive. Synchronization and interception were also problems; but Myer developed a cipher disk to ameliorate the latter problem, and in fact changed codes hourly if necessary.[28] Synchronization and communications security remain issues even today. Also, the long telegraph wires were quite vulnerable to interdiction and interception along the railroad lines, intentional or otherwise. Since the Army relied on the railroads for supply and transportation as well, the Signal Corps' problem was institution-wide.

Myer's tactical signalmen transmitted the telegraph messages on the second leg of their journey to the tactical commander. Analogous to a modern communications problem, the information reached a gateway at the train station and was re-formatted for local transmission by another means to the commander in the field. In this example, the two networks, though interfaced, did not provide

"seamless" flow of information because of the different "carriers" and essentially different standards. To this day the Signal Corps suffers from the persistence of belief that, somehow, electrons behave differently when summonsed for strategic as opposed to tactical purposes.

To summarize, the Civil War saw the development of discrete strategic and tactical communications capabilities. Commanders such as Grant employed both for operational purposes to link his tactical actions with strategic guidance from the commander-in-chief. The new telegraph technology drove the creation of Signal Corps train companies to support corps in the field. Congressional action prohibited the consolidation of control of military telegraph assets under one officer's control.

Operational Communications: 1900-1950

The first half of the 20th century brought two wars and with them technological changes upon which advances in communications utterly depend. In each case, the Signal Corps pioneered new organizations to support combat operations with the new technologies. In both cases strategic communications spanned oceans. Within the theater, combined communications organizations provided service to combined headquarters, while, at the tactical level, corps were supported by battalions and divisions by companies.[29]

The U.S. WWI experience was confined to Europe where the American Expeditionary Force (AEF) joined the latter stages of bloody trench warfare. Wire communications predominated. The Signal Corps' 50 field battalions and

19 service companies, comprising about 35,000 men, installed nearly 100,000 miles of wire to support the AEF with telegraphy and the relatively new telephone. Wireless telegraphy was less successful; the spark transmitters were heavy, cumbersome and difficult to tune. Trench warfare, dominated by firepower, exacted a heavy toll on the signalmen who installed and repaired the lines, as only AEF infantrymen suffered more casualties than signaleers. Pigeons actually played a key role as messengers in the St. Mihiel and Meuse-Argonne offensives when easily broken wire communications proved difficult to extend.[30]

The scale of warfare in WWII dwarfed the operations of just a generation earlier. Range and speed took center stage, as the former signal officer Heinz Guderian introduced *Blitzkreig*, debuting mobile armored warfare, enabled by radio communications and reinforced by the airplane. This technological means gave the commander unprecedented mobility and allowed for decentralized execution by subordinates.[31]

The Signal Corps grew rapidly to nearly 350,000 signalmen[32] supporting operations in both theaters, in diverse terrain and climates. Teletypewriting and machine encryption made strategic, transoceanic multichannel links faster and more secure. Radar debuted in support of early warning or air attack, and in directing anti-aircraft artillery. World War II also saw the first Joint-service communications units, as Joint Assault Signal Companies supported Army and Navy amphibious operations at Anzio, Normandy and elsewhere.[33] Pushbutton crystal-controlled frequency-modulated (FM) radios provided relatively static and interference free communications for combat units at the tactical level.[34] Patton's

Third Army's rapid advance in 1944, following the Saint-Lo breakout, was enabled by operational communications provided by 28 radio-relay truck units. Each corps was supported by a signal battalion, with divisions getting communications support from companies.[35]

As electronic communications proliferated in the 20th century, the Signal Corps also expanded its strategic mission. This expansion was particularly evident in the Pacific Theater in World War II. The initial step had been the extension of telegraph service into Alaska, via the creation of the Alaska Military Cable and Telegraph System, which offered wireless service in 1904. This system was comparable in scale to the first transoceanic cable links.[36]

Covering the vast expanses of the Pacific Ocean in WWII, however, required strategic multichannel radio-teletypewriter networks with multiple relay stations powerful transmitters and large antennas. The needs of joint service operations also had to be considered, to link naval, ground and air commanders together. This effort culminated in the construction of the Army Command and Administrative Net (ACAN), headquartered in the Pentagon. After the war, officials debated over whether the Army should maintain this world-wide network or turn it over to commercial vendors.[37]

Korea, following closely on the heels of the close of WWII, saw no real innovations in communications. Operational maneuvers, like the amphibious assault at Inchon, were relatively rare. Terrain and harsh weather dominated the conduct of operations on the Korean peninsula. Wire and telephone communications were subject to interdiction by the enemy's infiltration tactics, so

tactical FM radio, using relays on dominant terrain to overcome range limitations, was the primary communications means. Corps again had organic signal battalions, with cable construction, radio-relay, signals intelligence and maintenance units.[38]

Before turning to the next conflict fought in Asia, it is useful to recap the development of the Signal Corps in its first century. The Signal Corps began as a tactical and technical branch with the mission of extending the range and increasing the speed of communications service on the battlefield. Over the years, the Signal Corps created what became the National Weather Service and pioneered the fledgling aviation efforts that eventually became the U.S. Air Force. Signal Corps technical expertise produced radar, radio-telephone, and satellite communications. In essence, the Signal Corps provided the impetus behind the most far-reaching technological and organizational changes in the U.S. military, and it built world-wide networks to facilitate the prosecution of war in remote locales. Those networks remained functional after hostilities ceased, to connect the units left to perform occupation or forward presence duties. Those networks were, and are, operated by strategic signal units in peace and war. On the tactical side, signal force structure supporting the corps went from a field telegraph train, a company sized unit, in the 1860s to a battalion in the 1960s.

Communications in Vietnam

In Vietnam, geographical exigency and some specific technological developments influenced the amount and type of communications equipment and

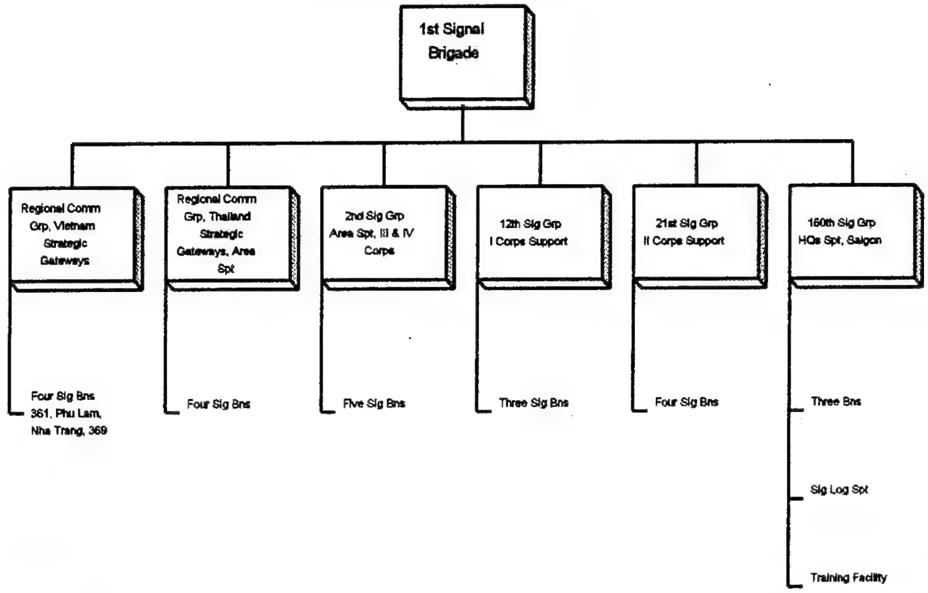
number of units and personnel employed. The remote theater placed a premium on inter-continental communications links, previously only available through transoceanic cable. The first uses of satellite communications (SATCOM) in a combat zone included both military and commercial links from Hawaii.[39]

The long narrow country stretched terrestrial radio links to maximum ranges. The new tropospheric scatter (TROPOSCATTER) radio systems extended telephone trunks over 200 miles to mitigate this situation. Gridded, or area-based, communications were modified into a more linear topology because of geography. Many signal sites served as mere relay nodes to extend communications into more remote areas.[40]

The signal force structure was large. 1st Signal Brigade of the U.S. Army Strategic Communications Command (STRATCOM) was the senior communications headquarters in Vietnam. It comprised, at the height of the conflict in 1968, six Signal Groups and 23 Signal Battalions, with a total of 23,000 signaleers. One of those groups (the 29th) supported units, mostly Air Force, operating in Thailand. Nevertheless, the 1st Signal Brigade, with nearly two times a division's worth of soldiers, was responsible for supporting multiple levels of command, namely, Military Assistance Command, Vietnam (MACV), a joint organization, U.S. Army Vietnam (USARV), the Army "component" command, as well as the area support for subordinate army corps.[41] [See Figure 1, below]

Theater Army Signal Brigade

Vietnam, July 1969



Rienzi, p. 114

The organizational demands for information by this cumbersome command and control structure created the "most extensive, expensive and sophisticated signals network in history."[42] By December 1968, 250 area communications links connected 220 installations and carried over 4000 voice channels. An additional 50 interconnections added 800 voice channels from the strategic Defense Communications System (DCS). To interconnect these, voice and message networks comprising 69 local switches, 64 message centers, and 8 message relay centers handled on the order of 100,000 messages and one million telephone calls per day.[43]

Command emphasis focused on tactical engagements in Vietnam. Typically, small units conducted most of the engagements with the enemy.[44] The

helicopter's debut as an airborne command and control platform was at least partly due to the compression of multiple levels of command in relatively small geographic areas. At that time, signal units had organic helicopters also for reconnaissance, combat photography (a Signal Corps responsibility since World War I), resupply and radio relays. To some extent these airborne platforms mitigated short range limitations of the tactical frequency modulated very high frequency radios. Their use as downward focused "directed telescopes" is well characterized by van Creveld; certainly they permitted over-supervision of tactical commanders.[45]

The focus of the communication effort paralleled the command focus in Vietnam: it was at the tactical level. Though a complex, integrated theater-level system was established, it did not have to support operational level maneuvers. In Vietnam, corps did not conduct "operational" warfare and did not need "operational" communications except in linking tactical headquarters to strategic communications resources.

Four army corps[46] operated in Vietnam simultaneously. Each corps was supported by two to six signal battalions that provided access to the fixed Corps Area communications systems. But it must be understood that these corps did not function as maneuver headquarters, though they had an organic tactical signal battalion for "mobile" combat communications. At the conclusion of the war, LTG Thomas M. Rienzi, one of the commanders of the 1st Signal Brigade in Vietnam, recommended that signal units should remain organic to division, corps, and field armies. But, he stated: "At Corps level, the present, large corps-

type signal battalion should be reorganized into at least two battalions under a group headquarters, with the commander dual-hatted as Corps Signal Officer."[47] This structural change did not occur in V or VII Corps in Germany until nearly ten years later, in the early 1980s.

One legacy of Vietnam for signal organization was that the 1st Signal Brigade, which had functioned *de facto* as a Theater Signal Command, incorporating tactical and strategic communications assets, remains to this day in Korea as the senior peacetime communications headquarters, consolidating control of both tactical and strategic signal units (two strategic battalions [41st and 36th] and two theater battalions [304th and 307th].[48] This brigade supports Korea on an area basis, and provides communications to the headquarters of both the Theater Army and the Commander in Chief, Combined Forces Korea.

The other legacy relevant to signal structure from Vietnam was the sheer number of communications units and signaleers involved. To be sure, there was little communications infrastructure present in Vietnam at the onset of the conflict, nor much in the way of road or rail networks along which communications usually run. A tremendous allocation of resources was devoted to the task of providing communications in an area of operations smaller than the state of Texas. After Vietnam, the Army retained a large active signal structure, ultimately creating a signal brigade to support corps, instead of just a battalion.[49]

Modern Operational Communications

When large bodies of armed men are assembled and expected to act in concert, the part played by communications cannot be overestimated.[50]

Communications Support for Operations Desert Shield / Storm

As Colonel Harry Summers, Jr. (ret) says in On Strategy II: A Critical Analysis of the Gulf War: " . . . operational-level thinking was the . . . hallmark of the (Army's) post-Vietnam renaissance."[51] Operational-level thinking and operational-level communications allowed the U.S. Army to demonstrate operational maneuver. This section analyzes the communications support for Operations Desert Shield/Storm, focusing on corps-level command and control communications provided by the 93rd Signal Brigade as well as the theater-level communications provided by the 11th Signal Brigade.

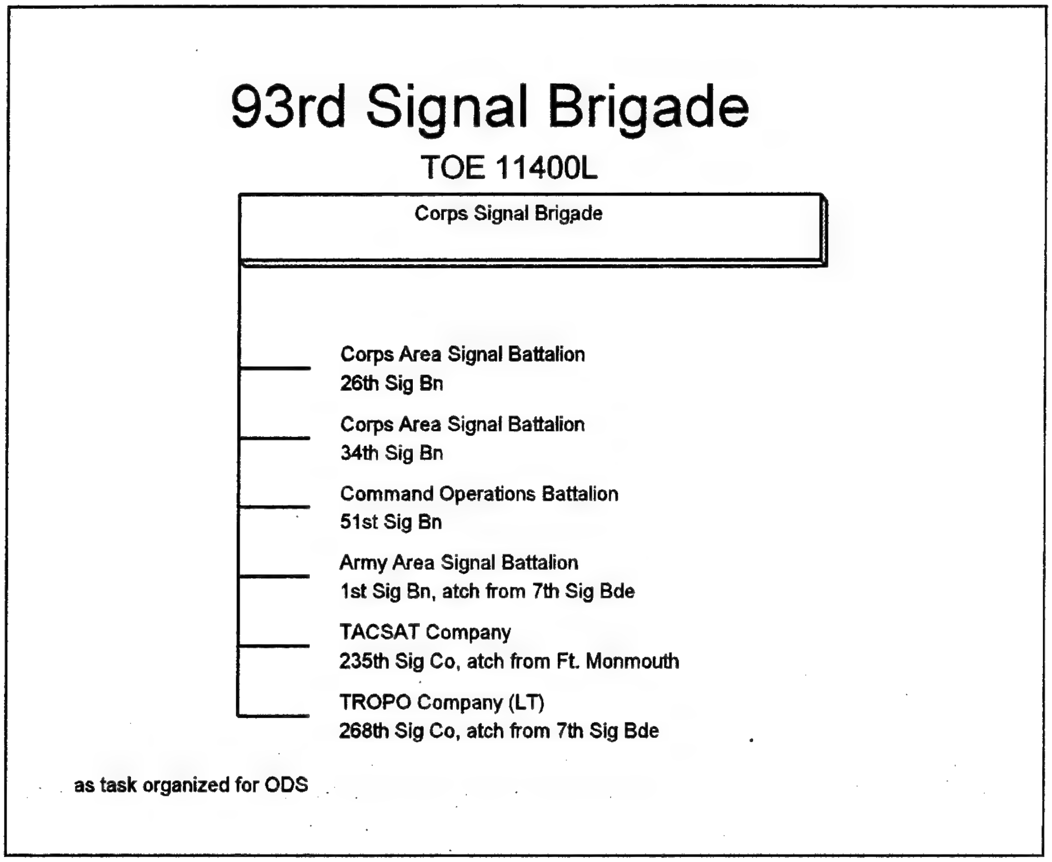
VII Corps deployed from Europe to provide the offensive combat power necessary for the ground phase of Operation Desert Storm. It contained, in its heavy "armored fist," its own 1st Armored Division, 2nd Armored Cavalry Regiment, 11th Aviation Brigade and VII Corp's Artillery. It was supplemented with the 3rd Armored Division, 1st Infantry Division (-) plus the French 2nd Armored Division, and ultimately received Tactical Control (TACON) of the 1st Cavalry Division (-) and the British 1st Armoured Division, comprising a total of about 150,000 soldiers.[52]

VII Corps' organic 93rd Signal Brigade provided the corps' tactical command and control links with four battalions. Two of these, the 26th and 34th

Signal Battalions, were corps area battalions that provided nodal network centers (or corps area signal centers [CASCs]). The third organic unit, the 51st Signal Battalion, provided command signal centers in support of the primary corps command centers. A fourth battalion was attached to the brigade. This was the 1st Signal Battalion, an army area signal battalion from the 7th Signal Brigade, the theater-level tactical signal brigade in Europe. It gave additional area coverage and headquarters support. Two units, a light troposcatter (TROPO) radio company from the 7th Signal Brigade (the 268th Signal Company) and a tactical satellite (TACSAT) company from Ft. Monmouth, NJ (the 235th Signal Company) were also attached. The size of the corps being supported and the large area of operations (AO) required these additional long-distance transmission capabilities. [53] [See Figure 2, below]

Volume 21a of the VII Corps "Desert Campaign After Action Report" (AAR) acknowledged that a problem facing the 93rd Signal Brigade was the integration of several generations of equipment.[54] The brigade had Tri-Service Tactical Communications (TRI-TAC), Improved Army Tactical Communications System (IATACS), and Digital Group Multiplexing (DGM) equipped units. The higher army-level signal organization in Saudi Arabia, the 11th Signal Brigade, also had TRI-TAC and DGM equipment;[55] however, the corps' five subordinate divisions had three different generations of switched communications systems. 1st Cavalry Division and 3rd Armored Division had the then new Mobile Subscriber Equipment (MSE),[56] 1st Infantry Division and 1st Armored Division had IATACS, and; the British 1st (UK) Armoured Division had Ptarmigan.

Figure 2.



The 93rd's North Atlantic Treaty Organization (NATO) association had given it working experience with an interoperability standard agreement (STANAG 5040), to interface the British network.[57] While the 93rd had not yet fielded MSE, it had been organizationally postured to receive the equipment and its network managers understood the capabilities and limitations of this new system.[58]

The Army chose MSE as a means to standardize common-user communications equipment at the corps and division echelons. In a doctrinal corps of five divisions covering about 37,500 square kilometers, a robust nodal

network topology of about 42 nodes services about 6,200 fixed and 1,800 mobile subscribers. MSE provides mobile subscribers a secure cellular radio-telephone capability and provides fixed subscribers both secure and non-secure telephone access as well as interfaces to Combat Net Radio (CNR)[tactical FM radio] users. The IATACS equipped 93rd, by contrast, could only install thirteen signal centers (nodes), including those from the 1st Signal Battalion, and so had inherently less flexibility to support fast-moving offensive operations, as leap-frogging these larger (but fewer) nodes forward is time-consuming and network reconfiguration a nightmare.[59]

A major shortcoming of the communications architecture, from the Corps G6 and 93rd perspective, was the relatively austere communications infrastructure in comparison to that found in Germany.[60] Frequently, tactical communicators in Germany had access to local commercial telephones for administrative and coordination traffic--this did not exist in the northern Saudi desert. In truth, as Air Force Lieutenant General James Cassity, then the Joint Staff/J6, put it: "We put more electronic communications connectivity into the Gulf in 90 days than we put in Europe in 40 years."[61] VII Corps simply could not access much of that capacity.

Satellite communications (SATCOM) solved this problem. When the brigade began arriving in November, it moved into a theater signal structure that had built up an unprecedented amount of SATCOM. Some commercial satellite ground stations were in theater, but few were close to the tactical assembly areas, so military SATCOM (MILSATCOM) proved its operational value. The U.S.

military employed 118 ground mobile forces (GMF) tactical satellite terminals in theater, comprising over half the total inventory. Some linked tactical forces with each other, some linked tactical forces in Saudi Arabia with support structures in Europe, and some linked back to sustaining base functions in the U.S. or worldwide networks. Twelve commercial satellite terminals were also installed. The Naval Space Command, manager of the Fleet Satellite Communications (FLTSATCOM) system, ran out of available bandwidth on their world-wide network of UHF satellites. The 93rd Signal Brigade installed twice as many multichannel TACSAT links as typical for a NATO scenario, and an unprecedented number of UHF TACSAT terminals.[62]

Communications network management presented an unusual challenge. As the Conduct of the Persian Gulf War stated: "It required substantial, innovative workarounds in both equipment and software."[63] Over 700 Telecommunications Service Orders (TSOs) provide substantial testament to the brigade's execution of numerous network reconfigurations. This essentially manual process took much time to produce and disseminate. Connectivity to VII Corps' major subordinate command (MSC) headquarters included SATCOM, line of sight radio, TROPO, and commercial cable or fiber optic links. Access to the Defense Switched Network (DSN) came via satellite to Defense Communications System (DCS) entry nodes. Traffic metering information shows that over 40 thousand messages were processed per day within the corps network alone.[64] Theater wide, 61 tactical circuit switches, and 20 tactical message switches were integrated into a worldwide network through approximately 329 voice and 30

message circuits.[65] The point here is that operational communications require world-wide messaging capability with large capacity switching.

Other communications lessons learned from the Gulf War point to future requirements implicit in continued success in "Information War." First, satellite communications proved critical to all operations. No other broadband long-distance transmission media can be moved into place as quickly. Although the total military SATCOM capability was exploited, it proved to be inadequate, and had to be augmented by other nations' resources, such as the British (NATO) Skynet.[66] Even experimental satellites were used to satisfy operational requirements.[67] Commercial SATCOM, always important in inter-theater communications, is even more critical in a large, immature theater with a relatively austere commercial communications infrastructure, and DSCS was the principal multichannel transmission system both in and out of theater.[68]

Second, operational communications systems engineering and management expertise was at a premium. Adaptability and re-configurability were showcased, as was a critical need for dynamic network control. Network management was a sub-optimized manual process since automated tools were not available. This confirmed the need for an automated, integrated communications systems control capability.[69]

Third, several operational interface issues surfaced. A technical problem between a tactical circuit switch in Riyadh and the commercial #5 ESS switch in Dranesville, Ohio took engineers from AT&T and GTE three months to fix; time we may not have in a future crises.[70] Army tactical switches needed software

modification to communicate with the Marine Corps' Unit Level Circuit Switch (ULCS); joint operations implicit in operational level warfare require seamless switched voice communications between the two land-oriented services. NATO STANAG 5040 specified network interfaces between TRI-TAC and the UK Ptarmigan and French *Reseau Integre des Transmissions Automatiques* (RITA) tactical systems. Since coalition warfare is the norm at the operational level, the number of potential interfaces is large, and relatively few comply with internationally recognized standards.[71]

The following future operational requirements were predicted. Data communications with global and near-instant access will be the standard. Though Saddam did not challenge our use of the electromagnetic spectrum, the U.S. cannot afford or assume a benign environment in future conflicts, so protection against jamming and interference will probably be required.[72]

The final critique of communications in Desert Storm points up the difficulty of supporting rapid sustained offensive operations. The mix of TRI-TAC, IATACS and MSE simply could not support the pace of the VII Corps commander's planned operational maneuver: units were strung out too far in linear arrangement and moved too fast for the brigade's nodal structure to flex in support.[73] A combination of factors caused this. The vast area of operation had almost no dominating terrain features from which to extend terrestrial backbone links. The area communications system was designed to support the flexing grid defined by the AirLand Battle doctrine; but, with few nodes to flex, the network possesses little elasticity when stretched by line-of-sight limitations. Relatively

static training, with infrequent high-level command post or signal nodal displacements, as practiced in Europe for many years,[74] also conspired to create a communications system lacking the agility to support high-paced armored desert warfare.[75]

Since Desert Shield/Storm, much has been done to alleviate the above mentioned problems, especially in satellite communications. The DSCS constellation has been replenished and is much healthier at present, but an adequate surge capacity must be planned for and provided. Many single-channel UHF TACSAT terminals have been built and issued. A new standard, Demand Assigned Multiple Access (DAMA) will allow more efficient use of limited UHF satellite channels and bandwidth. Extremely High Frequency (EHF) satellite technology has been demonstrated, and the first Military Strategic-Tactical Relay (Milstar) satellite has been successfully launched and operationally tested. Tactical communications have likewise been improved. The Army has fielded MSE to all division and corps signal battalions, including reserve component units. The new, frequency-hopping, reliable FM radio, Single Channel Ground Airborne Relay System (SINCGARS), has been fielded throughout the active force, and is being bought by allies.[76]

Many units that participated in Desert Shield/Storm are no longer in the force structure. The 93rd Signal Brigade has deactivated, as indeed did most of VII Corps. The V Corps, however, remains in Europe, and the 22nd Signal Brigade, now completely MSE-equipped, possesses a similar structure. While 22nd did not deploy to Southwest Asia, it has had the opportunity to take 93rd's

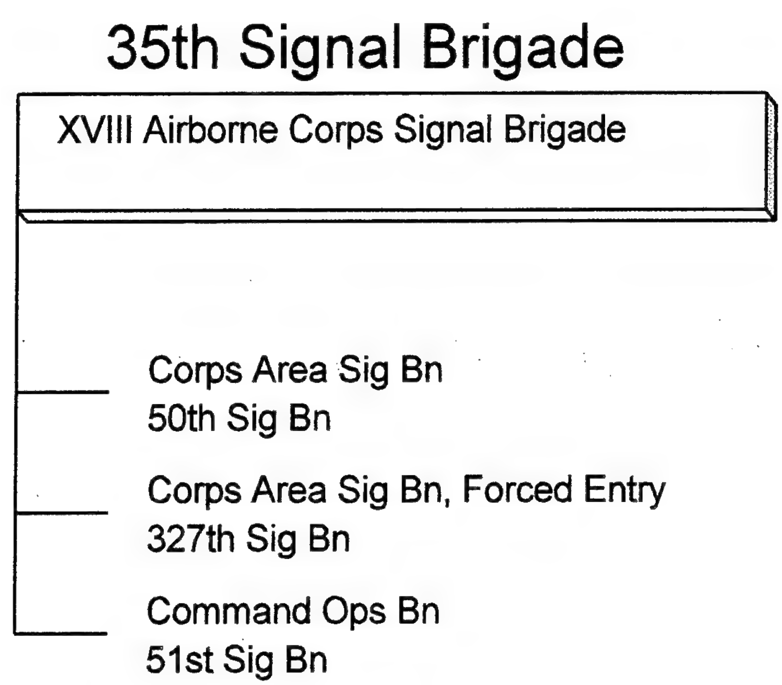
lessons learned to heart about the potential for deploying out of the mature European theater to conduct combat operations.

Communications Support for Operation Uphold Democracy

This section analyzes the communications support for Operation Uphold Democracy in Haiti, from September 1994 to April 1995, where both combat and non-combat operations, or Operations other than War, (OOTW) scenarios were planned in parallel. In this case, two separate JTFs were established, and communications support again came from a variety of tactical and theater organizations.[77]

The XVIII Airborne Corps' 35th Signal Brigade is no stranger to contingency force projection or joint and combined operations. By definition, the corps it supports is the Army's "contingency corps." In order to satisfy its unique mission, the 35th has an interesting mix of TRI-TAC and MSE equipment to provide a variety of capabilities. It has to support split based command and control because, frequently, only a brigade will deploy to a given hot spot while the parent division and corps headquarters remain at Ft. Bragg. It needs interoperable communications with Air Force assets since it relies on the Air Combat Command's 23rd Wing at Pope AFB (adjacent to Ft. Bragg) for its strategic mobility and tactical close air support. Finally, it requires lightweight equipment that can be transported on an airborne soldier's back, air-dropped, or air-landed from tactical lift aircraft. It possesses two forced entry contingency communications packages, Power Projection for Army Command and Control

Communications (Power Pac 3) companies, and Contingency Communications Package (CCP) / Light CCP.[78] The 35th depends heavily on single-channel TACSAT for its command nets (also called Warfighter Nets).[79] Possessing the same limitations in endurance and capacity as its parent unit, it is not meant for long-term commitment, unless reinforced. The brigade's basic organization is shown at Figure 3, below.



FM 11-30, MSE Communications in the Corps/Division, 1991, pp. C1-C2.

For Operation Uphold Democracy, XVIII Airborne Corps activated two different JTFs under Commander in Chief (CINC), United States Atlantic Command (USACOM). JTF 180 was formed by XVIII Airborne Corps around the 82nd Airborne Division to conduct combat operations, if necessary, to remove General Raoul Cedras from power and re-instate the democratically elected

President Jean-Baptiste Aristide. A parallel planning process formed JTF 190 around the 10th Mountain Division to perform OOTW in support of a fragile new government, should diplomatic efforts succeed.[80]

While negotiations led by former President Jimmy Carter were still under way, both JTFs were converging on Haiti simultaneously by sea and air. The advance element of the JTF 180 battle staff was embarked on the U.S.S. Mt. Whitney, a naval command and control platform designed to provide support for a floating JTF headquarters.[81] At the same time, airborne soldiers were combat loaded aboard C-130 aircraft and en route to Haiti when their combat assault was called off. The combat operation plan was terminated upon successful resolution of the negotiations; however, since the Mt. Whitney was already near Port-au-Prince, LTG Shelton retained command of the operation, and JTF 190 remained subordinate to JTF 180 during the initial stages. The Mt. Whitney stayed on station at Port-au-Prince harbor until about the early November. The JTF 190 staff was on the ground near the airport while the main elements of the JTF 180 staff were on the ground at Ft. Bragg. Clearly, JTF 190 needed good communications both with the Mt. Whitney and Ft. Bragg.[82]

Ship to shore communications presented an unusual network and interoperability challenge. For this operation, an MSE switch was installed and integrated on board the Mt. Whitney. During the daytime, DCS entry gave JTF 190 MSE connectivity to the Mt. Whitney via a DSCS link from Ft. Bragg to the ship and the typical DSCS link from the ship to USACOM at Norfolk. At night, when helicopter operations ceased, an MSE line-of-sight link augmented the

DSCS link to the Mt. Whitney. The Navy insisted the line-of-sight link interfered with air traffic control landing equipment for shipboard helicopter operations.[83]

An innovative sealift concept debuted in this operation. The 10th Mountain Division deployed aboard an aircraft carrier and used it as an in-theater staging base for a maneuver brigade. The 1st Brigade arrived in theater with its war fighting equipment on board the carrier and then self-deployed from the carrier to Port-au-Prince on the first day of operations. This was a great idea from a transporter's view point, but the communications on board the carrier were not designed to provide an additional robust command and control capability for an Army brigade embarked. Traffic overloaded the carrier's limited communications, consisting of two telephone circuits, one message circuit, and an unmanned WWMCCS station. The message traffic averaged an 18-hour backlog for IMMEDIATE traffic and the most reliable voice path was via International Maritime Satellite (INMARSAT) terminals set up on the deck of the carrier. If Navy ships are used to deploy and stage Army forces to war, they must be augmented with commercial or DSCS SATCOM connectivity.[84]

Initial communications ashore relied heavily on 35th Signal Brigade's single channel UHF SATCOM (or Warfighter) networks, supplemented by FM radio for ground to air and ground to ground communications. INMARSAT (also UHF) also linked ground headquarters. One forced-entry MSE switch, part of the Power PAC3 Company from the 35th, provided switched telephone service on 19 September.[85]

Once on land, JTF 190 had DSCS links to standard DCS entries into Ft. Detrick and Ft. Belvoir, plus a connection to the Air Force Reachback facility at Langley AFB in Virginia. It also had the previously mentioned DSCS link into Ft. Bragg extending MSE connectivity from Haiti to a corps MSE network at Ft. Bragg. Finally, AT&T provided an INTELSAT link to intelligence information at Ft. Meade.[86]

This robust satellite connectivity provided ample switched voice service. The Ft. Belvoir shot had seven DSN circuits over it, the link to Ft Detrick had twelve DSN circuits over it, and the Langley Reachback facility added twelve interswitch trunks to an Air Force switchboard providing additional connectivity into DSN and commercial networks. The DSCS shot to Ft. Bragg had 24 MSE interswitch trunks riding it. Another DSCS link terminated at Pope AFB where the 12th Air Force Air Operations Center (AOC) was located during the operation. There, twelve interswitch trunks gave DSN and local commercial telephone network access to the 12th Air Force, functioning as the Joint Forces Air Component Command (JFACC). The commercial SATCOM shot to Ft. Meade was provided by AT&T and was a T-1's worth of DSN and other voice circuits. All in all, JTF 190 had direct access to 55 DSN circuits and then shared access from another 36 interswitch trunks, all via SATCOM.[87]

The JTF's communications architecture philosophy called for dual connectivity and dual switching at all locations. Each of the brigades and the JTF headquarters had at least two independent links over different DSCS satellites. DISA allocated a large amount of DSCS bandwidth -- over 3 Mbps -- putting to

good use the healthier DSCS constellation that had been built up after Desert Storm.[88]

It is a rare thing to have more resources on the satellite than the ground segment can use, but 10th Mountain Division's organic signal unit, the 10th Signal Battalion, does not possess that many DSCS terminals. It brought its own GMF terminals, four TSC-93Bs and one TSC-85. But these were supplemented by Army assets from the 11th Signal Brigade, six TSC-93Bs with twenty foot antennas, to provide higher gain and more capacity, and Air Force terminals from both active combat communications groups and Air National Guard communications squadrons.[89]

Telephone switching assets also came from several other places. The JTF headquarters and non-maneuvering Army units such as the COSCOM and Military Police (MP) brigade were serviced by Air Force TTC-39s from the 3rd Combat Communications Group at Tinker AFB. In addition to the 35th's forced-entry switch, 10th Signal Battalion used all of its MSE switches. This hybrid network of TRI-TAC, in this case Air Force, and Army MSE switches was reminiscent of Desert Storm and the 93rd Signal Brigade. It provided a form of redundancy, since most key organizations had both MSE and TRI-TAC terminals available to them. 11th Signal Brigade also provided much of the cable and wire assets to install these subscriber instruments in support of the JTF.[90]

Message traffic included AUTODIN and Defense Data Network (DDN) connectivity. The JTF had two AUTODIN circuits; one from a DCS entry and one from a message switch at Ft. Bragg. Both circuits were terminated in an 11th

Signal Brigade message switch at Port-au-Prince. Relatively few subscribers used the AUTODIN service so traffic was correspondingly light, as five terminals handled around 100 messages per day. 11th Signal Brigade also provided a 56 kbps circuit from a DDN Mobile Gateway Van from Ft. Huachuca. DDN saw much greater use, as an average of 10,000 files were electronically transferred per day, for both mission data and morale electronic mail messaging to and from Ft Drum.[91]

The original plan called for gradually phasing out the Air Force and Army DSCS terminals and relying on commercial connectivity for access to DSN. However, after a couple of suicides, telephone morale calls gained great emphasis and all circuits were maintained through the end of the year. Roughly twice as many DSN calls were made at night as there were during the day. Morale phone service represents an increasing mission requirement, especially for occasionally protracted OOTW missions. Since the Vietnam-era of MARS phone patches, satisfying the needs for soldiers to call home is a fact of life for operational communications planners.[92]

In Haiti, the issue of commercial vendor service of this capability could have held litigious consequence. The Defense Information Systems Agency (DISA) liaison personnel made initial contacts with the vendors during the planning stages. DISA advised the J6 that the military had to provide equal access or opportunity to all vendors; ultimately, AT&T, MCI, and Sprint provided the service. Close, careful liaison with the commercial telecommunications

industry remains as important in OOTW in 1995 as it was for Alfred Myer in the Civil War in 1863.[93]

Another switched telephone service that saw much use was secure facsimile via Secure Telephone Units (STU-IIIs). To avoid pre-emption for the lengthy transmissions required for big classified documents, long-local service from Ft. Meade over the AT&T link maintained this capability. Such dedicated service is expensive, but necessary without secure packet message switched systems. Personal computers with data ports and modems provide additional load to switched systems.[94]

Two new extremely high frequency (EHF) satellite capabilities were demonstrated. The first provided secure video-teleconferencing support for National Command Authority (NCA), CINC and JTF Commander conferral, as the National Aeronautic and Space Administration's (NASA) new Advanced Communications Technology Satellite (ACTS), showcased wide-band satellite capability and compressed digital imaging simultaneously for the first time. This feature subsequently was also used for morale support, providing video-teleconference calls for soldiers to see and talk to loved ones in Ft. Drum and elsewhere. This capability could prove very useful for tele-medicine and advanced imaging applications, if industry chooses to build follow-on satellites.[95]

USACOM also encouraged the first use of the Military Strategic Tactical Relay (or Milstar) system. This system, designed for survivable low data rate communications, gives the military its first EHF satellite capability. In Haiti it may have been more helpful in the initial stages, when the JTF was dependant on

relatively few single-channel systems. Instead, it was tried only after the mature network was established, and it really could not compete or compare with the wideband multi-channel systems. Prototype single-channel multi-purpose (SCAMP) terminals proved only marginally capable, with reliability problems and the usual bugs in first time operations.[96]

Another mission requirement not found except in the tenet of "versatility" that consumes significant operational resources is providing mobile communications to support visiting dignitaries. 35th Signal Brigade provided portable UHF TACSAT and INMARSAT terminals for VIP support, and 10th Signal Battalion provided the operators. A High Mobility Multi-purpose Wheeled Vehicle (HMMWV) with a geo-steerable antenna mount enabled UHF TACSAT communications on the move for visitors such as the Secretary of Defense, CJCS, CINCACOM, and congressional representatives.[97]

Access to international television media is another modern mission requirement. Cable News Network access is ubiquitous in command centers world-wide. Haiti was no exception: JTF leadership used it to gauge the American public's reaction to progress in Haiti. It was also employed, though perhaps to a lesser degree, as an intelligence source, as when looters were breaking into food warehouses around Port-au-Prince in late September. The 35th's communicators left their CNN dish and large-screen televisions to continue to support the 10th. Military media sources such as Armed Forces Radio and Television Service (AFRTS) and the "Early Bird" were likewise needed. The "Early Bird" came in via unsecure commercial facsimile and gave senior leaders

additional insight into American public opinion, especially in the very early stages of the operation.[98]

To summarize, in Haiti, even the 35th Signal Brigade, despite its mix of TRI-TAC and MSE equipment and comprehensive experience with joint operations, required augmentation from a theater signal brigade, as well as other Service communications support, to provide the operational communications required by its corps/ JTF headquarters. Much of this augmentation was not new or unique: it is simply an issue of requirements exceeding existing capabilities. In this case, as in Operation Desert Shield/Storm, the answer was more satellite capacity, in space and on the ground. Modern operational communications needs satellite resources, previously held in strategic echelons. The satellite overcomes the tyranny of terrain, and tactical commanders need to be freed from this limitation of line-of-sight radio, much as Guderian's radio enabled commanders of mechanized forces to move around those bound by telephone wire, and as the telegraph and railroad allowed Grant the freedom to pursue distributed operations.

Information technology may be advancing by leaps and bounds, but the demand for information resources is taking quantum leaps. New devices or services that the newly competitive telecommunications industry provides its commercial customers are demonstrated and procured "off the shelf."[99] The only way a shrinking military can do more with less is to have more ability to quickly move information and forces around the battlefield. So, merely having more satellite resources will not suffice. High-capacity data-switching systems are also

badly needed, whether or not the battlefield actually gets digitized.

Military communicators have continued to be first in and last out, at least geographically. They used to lead the way in technological developments, as well, especially in electronic communications. That is no longer true in the arena of general administrative or office automation information systems. And the customers that are demanding more and more services from AT&T and Sprint are also sophisticated "users" of military battlefield information systems.[100]

The signal brigade supporting the corps today has MSE and relatively few satellite terminal assets. MSE's packet switched network overlay will help meet the data-switching requirements, but additional capability to access larger data networks, such as the Defense Data Network (soon to be the Defense Information Systems Network, or DISN) and the Internet is also needed. The new satellite terminals for Milstar and a healthier DSCS system bring overdue improvement. Also overdue, however, is a look at how the Army might put together pieces of various communications organizations that might create a better corps signal brigade. Accepting LTG John H. Cushman's proposition that "future corps commanders will operate as JTF commanders,"[101] this study of operational communications looks next at where those pieces can be found.

Matrix of Success: Capabilities of the Joint Communications Team

. . . the Chinese ideograph for "crisis" is made up of two characters, one meaning "catastrophe" and one meaning "opportunity:" Cohen and Gooch[102]

Two strategy professors at the Naval War College, Eliot Cohen and John Gooch, posit that military failures can be attributed more often than not to organizational failures. Their book, Military Misfortunes, discusses failures of military organizations to anticipate, learn, or adapt to changing circumstances. Success, however, can also provide cause and opportunity for organizations to adapt: what works once may provide a model for change. This section modifies Cohen and Gooch's "matrix of failure" into a matrix of success, to determine what characteristics of recent successes in operational communications should be carried forward into future Army corps signal organizations.[103]

Each of the Services has created, or task organized, objective structures consisting of combinations of different component units to take advantages of the capabilities of each and make a synergized whole. The Army creates combined arms task organizations, mixing heavy, light, and aviation forces into combined arms teams. The Air Force has set its sights on composite wings as an objective force structure. Naval forces have always operated as battle groups. Since "Joint warfare is essential to victory,"[104], perhaps joint communications organizations are best suited to provide the corps commander, acting as a JTF commander, with the best operational command and control support. Operational communications resources should be organized for success, to take best

advantage of the opportunity for information dominance, exploit technological developments, and avoid wasteful duplication of effort.

As shown in Operations Desert Shield / Storm and Uphold Democracy, assets from different units or services were combined to create the corps' and JTF's command and control structure. Table 1 below depicts candidates for operational level communications units of the four Services:[105]

Table 1

	Four Star HQ	Three Star HQ	Two Star HQ
ARMY	Theater Sig Cmd Theater Sig Bde	Corps Sig Bde Corps Sig Bn	Div Sig Bn
AIR FORCE	Comm Grp Cbt Comm Grp Air Control Sqn	Comm Grp Cbt Comm Grp Air Control Sqn	Comm Grp/Sqn Cbt Comm Grp Cbt Comm Sqn
NAVY	NAVCOMSTA C2 Ship	NAVCOMSTA C2 Ship	NAVCOMSTA C2 Ship
MARINES		SRIG Sig Bns	FSSG Sig Cos

For the Navy, the command and control process is fairly straightforward; once embarked, the commander of the ship, task force, battle group or fleet is in charge. He is linked through Naval Communications Stations around the world or by satellite links with his land-based higher headquarters fleet or CINC. The carrier is the usual capital flag ship from which naval command is exercised. However, the U.S.S. Blue Ridge and Mt. Whitney provide specially equipped platforms for a JTF headquarters to exercise command and control afloat.[106]

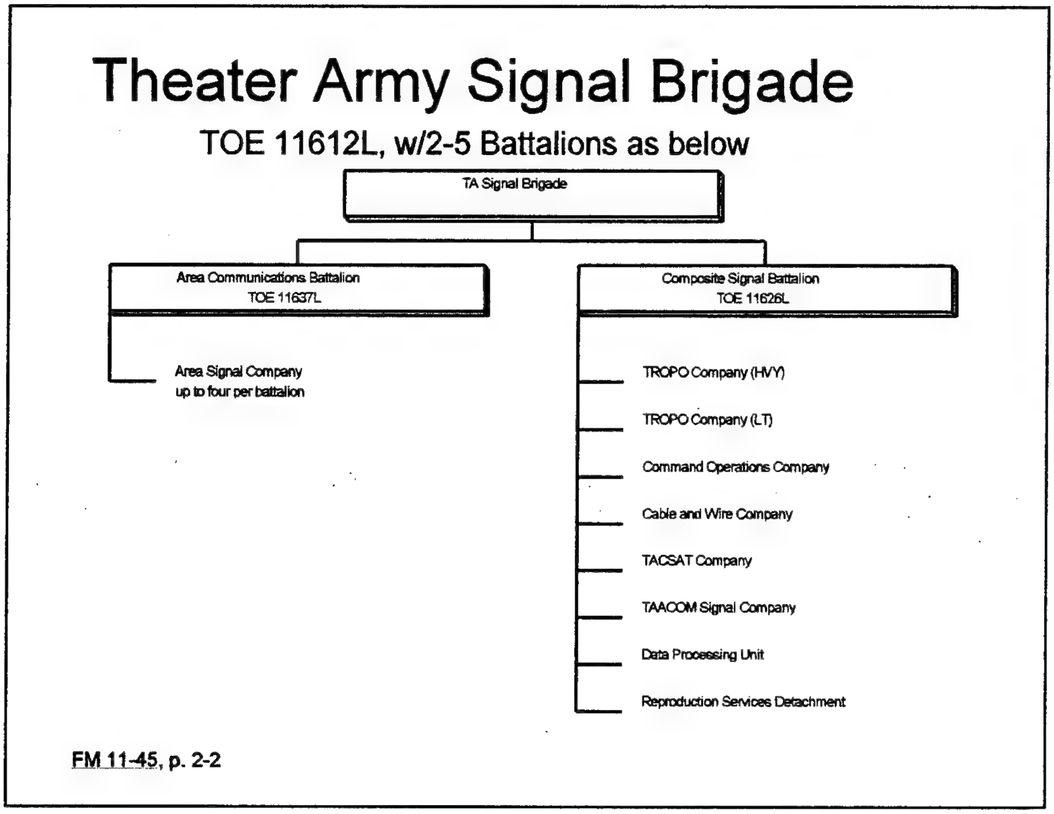
For the Air Force, the Theater Deployable Communications (TDC) Program defines communications and air control units that will deploy to support

each combat air force, wing, or squadron when deployed. Characterizing mission packages as small, medium and large for communications unit sizing, it also includes provisions for equipping Air Operations Centers (AOCs) for a Joint Forces Air Component Commander (JFACC), which is a key component of a JTF. Active and reserve components communications groups and squadrons provide the communications equipment and personnel.[107]

The Marine Corps relies on the Navy for command and control while embarked, and possesses only a relatively austere capability for large unit level communications support once ashore. So, if large land forces were involved, and the corps commander was a JTF commander with a Marine component including a senior Marine headquarters like a Marine Expeditionary Forces (MEF) or Marine Division (Mar Div), the Army signal organization would provide both liaison and area communications support to the Marine headquarters. As Joint Pub 6-0 says, "communications and C4 systems can be employed as follows: senior to subordinate, supporting to supported, left to right . . ."[108]

A typical Army organization that provides theater-level communications resources are the 1st Signal Brigade in Korea, the 7th Signal Brigade in Germany and the 11th Signal Brigade at Ft. Huachuca. Previous chapters described how 1st Signal Brigade functioned during Vietnam and how 7th Signal Brigade augmented 93rd Signal Brigade during Operations Desert Shield / Storm. The common element in Operations Desert Shield/Storm and Uphold Democracy has been large scale participation by the operational theater tactical 11th Signal Brigade from Ft. Huachuca and the U.S. Army Information Systems Command.

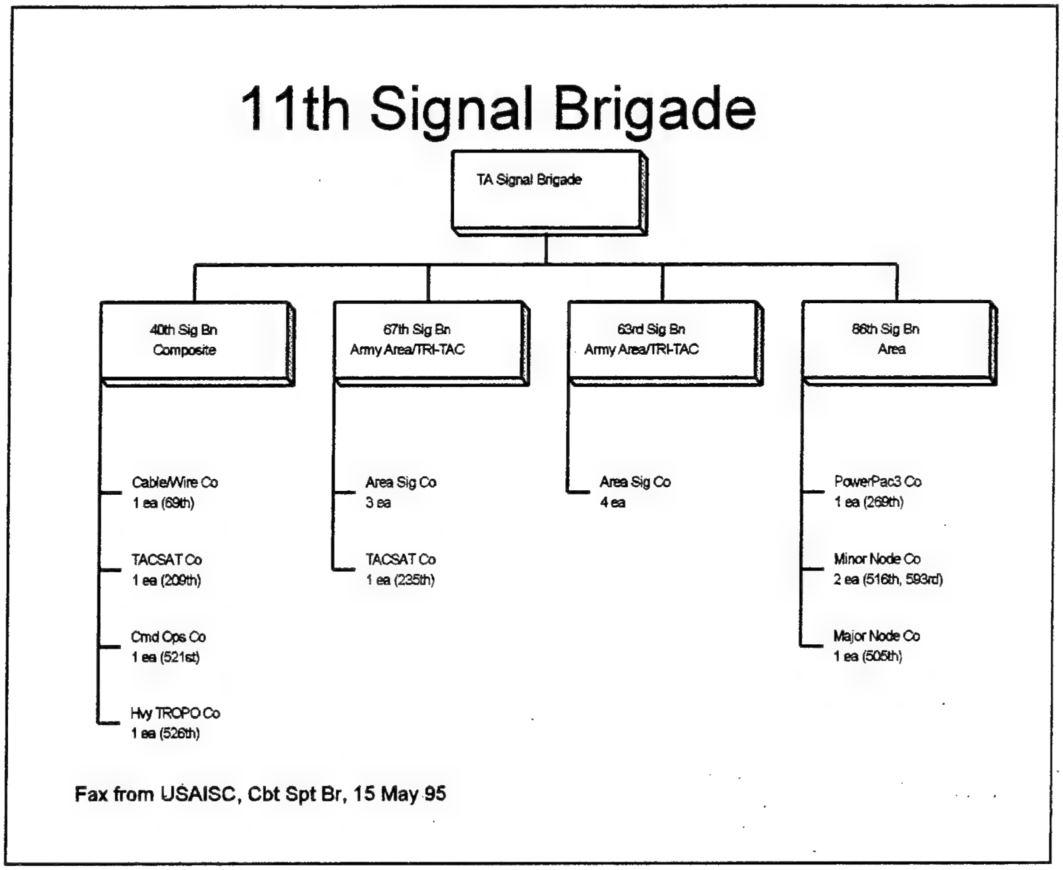
The theater army level signal brigade is organized under TOE11612L with two to five battalions comprising any mix of area telecommunications battalions and composite battalions.[109] The individual companies under a composite battalion headquarters are considered "building blocks" providing specific additional capabilities. [See Figure 3 Below]



The 11th Signal Brigade's actual organization is shown below in Figure 4. It is tasked under the provisions of JCS Memorandum of Policy (MOP) 3 for tactical (mobile or transportable) communications assets:

> . . . essential for providing C3 connectivity and service to deployed elements of unified and specified commands during contingency, crisis, and wartime situations.[110]

Figure 4.[111]



These taskings are not by subunit type, but rather are specific numbers of communications assemblages.[112]

Also tasked under MOP 3 is the Joint Communications Support Element (JCSE), which formally supports U.S. Commander in Chief Central Command (USCINCCENT) and U.S. Special Operations Command (USSOCOM). JCSE, commanded by an Army lieutenant colonel, has about 450 military personnel from all services in an active duty organization, and is augmented by two Air National Guard (ANG) Joint Communications Support Squadrons (JCSS), the 224th from Brunswick, Georgia and the 290th from MacDill AFB, Florida.[113]

As DOD's Conduct of the Persian Gulf War states: "The JCSE demonstrated that the design and concept of a joint communications support organization is sound and necessary."[114] Does that mean all regional CINCs should have a JCSE-clone? It is likely that each of the warfighting CINCs J6s would welcome a JCSE-like organization to be a component of their operations planning. JCSE can split into two separate but equal organizations to support two JTFs and two Joint Special Operations Task Forces (JSOTF) simultaneously; but, as we have seen, two JTFs may be formed for one operation to provide flexible options.[115]

The JCSE, however, is directly controlled by the JCS/J6Z, Contingency Support Division. Under the provisions of MOP 3, any organization can request assistance from the JCS for use of JCSE assets for contingency communications. The requestor must identify the purpose, mission, duration and exact support assemblages requested, by Unit Type Code (UTC). The requestor also provides funds for this support.[116]

The assets identified in JCS MOP 3 include primarily satellite communications terminals, TROPO terminals, HF, UHF and SHF radio assemblages and repeaters, message and voice switching systems, and communications systems control elements. The point here is that these assets are considered "tactical" though tasked by the JCS to perform operational missions in support of JTFs. Most of the equipment listed as coming from 11th Signal Brigade and JCSE can be found also in the 281st Combat Communications Group (AFNG), which supports the 17th Air Force.[117]

In Germany, 7th Signal Brigade, like the 11th Signal Brigade, is organized to bridge the gap between tactical and strategic communications in the European theater. It belongs to USAISC's 5th Signal Command, which also oversees NATO Regional Signal Support Groups in Belgium and Italy. As described earlier, the 7th Signal Brigade did not deploy to South West Asia *en masse*, but was used to augment the 93rd Signal Brigade to support VII Corps. It currently has one area battalion, the 44th and one composite battalion, the 72nd. It frequently interoperates with V Corps' 22nd Signal Brigade in NATO, EUCOM or USAREUR exercises. During the 1994 exercise "Atlantic Resolve," in which V Corps performed as a JTF headquarters, the following were lessons learned by the 22nd Signal Brigade:

- connectivity to Air Force TTC-39A telephone switches; their static routing tables do not interoperate with the MSE-equipped brigade's flood search routing.

- World Wide Military Command and Control System (WWMCCS) expertise is lacking in the Corps staff.[118]

- adequate gateways between MSE's Tactical Packet Network (TPN) and DDN must be created, since data transmission requirements and Local Area Network (LAN) accesses are proliferating, even at tactical headquarters.[119]

Each of these problems has been identified and discussed earlier. The switch interoperability was described in both Operations Desert Shield/Storm and Uphold Democracy. The WWMCCS problem also occurred in Uphold Democracy, and adequate data switching is a common problem throughout the

military. The switching problem cannot be fixed easily unless the Air Force gets TTC-39D switches. The WWMCCS problem would occur even if 11th Signal Brigade provided the communications resources. The data network access problem can be fixed by creating more mobile DDN Gateway assets like those in the 11th Signal Brigade. The relative lack of satellite communications assets in the 22nd Signal Brigade did not surface in a simulated command post exercise environment.

The major limitations of the MSE Corps Signal Brigade in supporting a JTF are just three: 1) relatively few long-range high-capacity transmission systems, like multichannel satellite and troposcatter terminals; 2) static routing based telephone switching (TRI-TAC) like that found in the Air Force and Marine Corps, and; 3) large capacity data transmission (best accomplished with packet switching technology) throughput. As has been shown, overcoming these limitations has been necessary in the two must recent successful, large-scale operations. These operationally vital assemblages can be found in active and reserve component and Air Force and Army communications units that are subject to contingency tasking by the Joint Staff. It is merely an issue of putting the pieces together under one organization.

Implications and Recommendations

Don't find fault. Find a remedy.--Henry Ford[120]

As everyone knows, the Army is shrinking. The entire active Army today does not have as many armor battalions as LTG Frederick Franks, then commanding the VII Corps in Operation Desert Storm, had for his operational maneuver in the desert. From a steady-state of around 750,000 in seventeen divisions in the mid-1980's, the Army has drawn down in the post-Cold War era to around 500,000 and ten divisions in 1995. Recently, the Secretary of Defense has told the Army to come up with another 20,000 in force reductions. With leaders questioning our ability to sustain our National Security and Military Strategies with the forces currently on hand, serious thought must be given as to where to make these cuts. While reserve components communications units can and do supplement active units, consolidation of active headquarters organizations could help achieve some of these cuts.

The dimension of space has to some extent rendered irrelevant the distinction between tactical and strategic communications. Satellite communications fundamentally enables force projection operations. Just as logistics capabilities "over the horizon" enables a Marine force to derive support ashore, so space-based communications provide the ultimate extension of information from the sustaining base into a specific theater of operations, though it may be on the other side of the world. With robust satellite communications, command echelons and sustaining base functional managers need not deploy to a

theater in order to provide support. Operational echelon communications forces could be consolidated under either higher or lower command echelons.

Signal organizations should be designed, organized, and equipped to be just as deployable and flexible as the headquarters and units they support. 11th Signal Brigade, with a wide variety of potential operational environments, possesses a broad range of communications assets from tactical single channel systems to strategic satellite terminals. 35th Signal Brigade has both TRI-TAC and MSE equipment to link the contingency corps with its supporting strategic mobility assets and tactical close air support assets. 22nd Signal Brigade must be prepared to support NATO commitments to the Allied Command Europe's (ACE) Rapid Reaction Corps, of which the 1st Armored Division forms a part, so NATO interfaces are requisite for 22nd's missions.

Some have posited the creation of a "Joint Information Corps" to best take advantage of and leverage the technological innovations of the information revolution. Consideration should be given to consolidating communications organizations into joint units. If the Defense Information Systems Agency and JCSE provides appropriate models, then some sort of Joint Information Corps could be established; but, as Libicki and Hazlett noted, such a corps would meet much bureaucratic resistance to change.[121]

While this jointness may not be bureaucratically feasible in terms of building a Joint Table of Distribution and getting personnel authorizations to fill a corps signal brigade, the European brigade could create wartime liaison offices for the following functions: 1) Navy/Marine Corps communications liaison to

accept ANGLICO companies or other Naval communicators; 2) Air Force Combat communications liaison, and; 3) NATO interoperability/liaison. It could be supplemented with TRI-TAC equipment, as its brother, the 93rd, was during Operation Desert Storm. It could be augmented with better DDN access such as the 11th's mobile gateways, and it could be equipped with more satellite and troposcatter equipment. If it were, the 22nd Signal Brigade could provide better communications support to a JTF headquarters.

A problem arises in implementing a solution. There is no single Army proponent for Signal force structure issues. USAISC and USASC&FG must arrive at some common viewpoint. As corps and divisions deactivate, so do the tactical communications organizations that support them; yet the Army maintains the same echelons above corps signal structure, in terms of brigade headquarters, in Europe that it had when there were two corps and more than four divisions--now there are only four ground maneuver brigades. Perhaps this headquarters structure is excessive, but it will be difficult to achieve consensus on appropriate action.[122]

Summary

There is more hope for a confessed sinner than a conceited saint.[123]

This monograph has described the schism between tactical and strategic communications that began with the birth of the Signal Corps in the Civil War and the fight between Stager's commercially oriented telegraph and Myer's tactical field telegraph organizations. When operational maneuver was possible, it was enabled by the railroad and the telegraph and the combination of strategic and tactical communications. World War II required innovative application of new technologies to support mobile armored warfare: the operationally significant radar and radio enabled operational protection and maneuver, such as Patton's breakout or Rommel's North African campaign. The concept of theater armies also matured and strategic signal organizations began building world-wide networks. Space communications debuted in Vietnam, but were not employed to change the operational characteristics of this unconventional struggle. It became clear that, if corps were to function as maneuver headquarters, a new way of thinking would have to be inculcated, and additional communications assets would be necessary.

Operational communications had a modern revival in Operations Desert Shield/Storm and Uphold Democracy. Actions in Southwest Asia and Haiti provided modern case studies in which to examine Army signal force structure and employment in support of Army corps in operational warfare. Desert Storm was enabled through airpower and precision strikes paralyzing the enemy's

command and control and protection capabilities, with operational deception and maneuver facilitated, and ultimately disabled by world-wide information dissemination through real-time satellite video images. Army corps, however, still were tied to an essentially gridlocked doctrine for communications, with inadequate resources to support independent high-speed sustained maneuver. MSE had not yet been fielded throughout the corps. Operation Uphold Democracy proved the Army's ability to conduct "simultaneous application of complementary capabilities," for both combat operations and OOTW.[124] Yet it also showed the dependence on joint and contingency communications assets that are in short supply and some of the limitations of MSE in supporting joint operations.

For the corps signal brigade in Europe to provide operational communications to best support a JTF headquarters, it needs the following:

- a mix of both MSE and TRI-TAC equipment
- more long-range transmission equipment (SATCOM and TROPO)
- more data transmission capability (robust TPN and DCS entry)

These capabilities are currently found in theater tactical signal brigades. XVIII Airborne Corps' 35th Signal Brigade possesses an operational mix of this equipment because of its contingency mission requirements. JCSE has similar capability in smaller packages to support CENTCOM and SOCOM and other contingencies as required, but it make little sense to further task this already busy organization. Bureaucratic resistance might prohibit creating another JCSE for EUCOM. 11th Signal Brigade is the most robust theater signal brigade, but, as it

is tasked to provide its "tactical" assets under multiple contingency scenarios in several theaters, this unit should be left as is.

However, the satellite and troposcatter radio, switching and strategic data network entry assets are also found in the two-battalion theater signal brigade in Europe, the 7th Signal Brigade. This study concludes that the Army should combine the 7th and 22nd Signal Brigades into a composite unit to provide support to both USAREUR and V Corps Headquarters, somewhat like the support 1st Signal Brigade provides in Korea as legacy from Vietnam. The distinctions between the two organizations become irrelevant in a joint and combined operational warfighting environment: they ultimately get combined in a theater-tactical network anyway. An individual consolidation of headquarters may represent only a small step towards achieving requisite force reductions; but, long marches are mostly made up of small steps. It will also help organize for future success, based on past experience.

BIBLIOGRAPHY:

Articles

Ackerman, Robert K., "Low-Cost Imagery Processing Reaches Echelons Corps and Below," Signal, (Volume 49, No. 7, March 1995), pp. 47-49.

Brendler, Joseph A., CPT, USA, "Tactical Military Communications," Journal of Electronic Defense, (Supplement to January 1995 Edition), pp. 67-71.

Cummings, Dennis and Anson, Sir Peter, "The First Space War," in First Information War, Alan D. Campen, ed., (Fairfax: AFCEA International Press, 1992), pp. 121-133.

Cushman, John, H., LTG, (ret), "Make it Joint Force XXI," Military Review, (Volume LXXV, March-April 1995), pp. 4-9.

Epstein, Robert M., "Patterns of Change and Continuity in Nineteenth-Century Warfare," The Journal of Military History, (Volume 56, No. 3, July 1992), pp. 375-388.

Ferrell, Robert, S., MAJ, "Operation Uphold Democracy: Contingency Communications and Forced Entry Operations for Haiti," Army Communicator, (Volume 20, No. 1, Winter 1995), pp.7-14.

Goins, Lorenzo A., MAJ, "What the heck is STANAG: Solving the Interoperability Puzzle," Army Communicator, (Volume 17, No. 1, Spring 1992), p. 3.

Grimes, Vincent P., "U.S. Army Begins Digitization Build-Up," International Defense Review, (Volume No. 27, July 1994), pp. 51-55.

Hazlett, James A., and Martin C. Libicki, "Do We Need an Information Corps?" Joint Force Quarterly, (Autumn 1993, No. 2), pp. 88-97.

Hewish, Mark, "Fishing in the Data Stream," International Defense Review, (Volume No. 27, July 1994), pp. 51-57.

Kelly, Brian J., "Command and Control Basics Enhance Explosion of Information Technology," Signal, (Volume 49, No. 7, March 1995), pp.15-16.

Matthews, William, "Girding for Cyberwar," Air Force Times, (Volume 54, No. 50, 18 July 1994), p. 36.

Ohle, David H., BG, USA, "Force XXI: The Campaign Plan," Army, (Volume 45, No. 2, February 1995), pp. 19-20.

Paige, Emmett, Jr., "Re-Engineering DOD's C3I Operations," Defense 93, (Issue 6, 1993), pp. 15-22.

Rigby, Joe W., MG, USA, "Digitizing Force XXI: A Team Effort," Army, (Volume 45, No. 5, May 1995), pp. 36-44.

Robinson, Clarence A. Jr., "Critical Link Consolidates Army's Tactical Networks," Signal, (Volume 49, No. 7, March 1995), pp. 24-27.

Roos, John G., "InfoTech InfoPower," Armed Forces Journal International, (Volume 131, No. 11, June 1994), pp. 31-36.

Slupik, Jean, "Integrating Tactical and Strategic Switching," in First Information War, Alan D. Campen, ed., (Fairfax: AFCEA International Press, 1992), pp. 143-148.

Takeguchi, Earl and Wooley, William J. , "Spectrum Management," in First Information War, Alan D. Campen, ed., (Fairfax: AFCEA International Press, 1992), pp. 155-160.

Toma, Joseph, "Desert Storm Communications," in First Information War, Alan D. Campen, ed., (Fairfax: AFCEA International Press, 1992), pp. 2-5.

Walsh, Edward J., "Navy Drives Development for Joint Command-Control Vision," Seapower, (Volume 37, No. 8, August 1994), pp. 25-26.

Wentz, Larry, K., "Communications Support for the High-Technology Battlefield," in First Information War, Alan D. Campen, ed., (Fairfax: AFCEA International Press, 1992), pp. 29-32.

Williamson, John, "Keeping all in contact," Jane's Defence Weekly, (Volume 21, No. 8, 5 March 1995), pp. 21-22.

Government Documents

Chairman, Joint Chiefs of Staff. Memorandum of Policy #3, "CJCS Controlled Communications Assets", (Washington D.C.: CJCS, 1990).

______. Military Commission Memorandum (MCM) 140-93, "CJCS Controlled JTF Communications Capabilities," (Washington D.C.: CJCS, 29 October 1993).

______. Joint Pub 1, Joint Warfare of the U.S. Armed Forces, (Washington D.C.: National Defense University Press, 1991).

______. Joint Pub 6-0, Doctrine for Command, Control, Communications and Computer Systems Support to Joint Operations, Chapter VI, "Global C4 Instructions," (Washington D.C.: Office of the Chairman, Joint Chiefs of Staff, 1992).

Headquarters, 3rd Signal Brigade. Draft Report: "How to Fight MSE," (Ft Hood, TX: 1994).

Headquarters, VII Corps, "Desert Campaign After Action Report (AAR)," (Volume 21a, 93rd Signal Brigade, undated) being archived by the Combined Arms Center Historian, Ft. Leavenworth, KS.

Headquarters, Joint Communications Support Element. "Joint Communications Support Element C4 Systems Planner's Guide," (MacDill AFB, FL: 1994).

Office of the Secretary of Defense. Conduct of the Persian Gulf War: Final Report to Congress, Appendix K, "C3 and Space," (Washington D.C.: OSD, 1992).

U.S. Department of the Air Force. Air Force Theater Deployable Communications Program Roadmap, (Washington, D.C.: Department of the Air Force, 1993).

______. Space Handbook, Volume One: A Warfighter's Guide to Space, (Maxwell Air Force Base, AL: Air University Press, 1993).

______. Space Handbook, Volume Two: An Analyst's Guide, (Maxwell Air Force Base, AL: Air University Press, 1993).

U.S. Department of the Army. The Army Budget, (Washington D.C.: Army Budget Office, 1990).

______. FM 11-30 MSE Communications in the Corps / Division, (Washington D.C.: Government Printing Office, 1991).

______. FM 11-45 Signal Support: Echelons Above Corps (EAC), (Washington D.C.: Government Printing Office, 1992).

______. FM 11-50 Combat Communications within the Division (Heavy and Light), (Washington D.C.: Government Printing Office, 1991).

______. FM 24-1 Combat Communications, (Washington D.C.: Government Printing Office, 1985).

______. FM 100-16 Final Approved Draft, Army Operational Support, (Washington D.C.: Government Printing Office, 1995).

______. Force XXI . . . America's Army of the 21st Century, (Washington D.C.: Office of the Chief of Staff, 1995).

______. Signal Branch Bulletin, (Washington D.C.: PERSCOM, July 1994).

______. Student Text 101-5 Command and Staff Decision Processes, (Fort Leavenworth, KS: U.S. Army Command and General Staff College, 1994).

______. Tables of Organization and Equipment (TOEs), 11 Series Published Tables, (Signal Organizations):
EAC Signal Brigade (11612),
Signal Telecommunications Battalion (AREA) (11635),
Signal Battalion, Composite (11626),
Headquarters, Theater Signal Command (11602);
Signal Brigade, Corps (11400), microfiche, (Washington D.C.: Deputy Chief of Staff, Operations, current as of 15 Oct 93).

______. TRADOC Pamphlet 525-5 Force XXI Operations, (Fort Monroe, VA: U.S. Army Training and Doctrine Command, 1994).

______. TRADOC Pamphlet 525-11-1, Leadership and Command on the Battlefield: Operations JUST CAUSE and DESERT STORM, (Fort Monroe, VA: U.S. Army Training and Doctrine Command, 1992).

______. U.S. Army Space Reference Text, (Fort Leavenworth, KS: U.S. Army Space Institute, 1993).

______. The Use of INTELSAT and INMARSAT to Support DOD Communication Requirements, (Colorado Springs: U.S. Army Space Command, 1993). NOTE: not approved for public release.

U.S. Department of the Navy. FMFRP 1-11 Fleet Marine Force Organization, (Washington D.C.: Government Printing Office, 1992).

______. Naval Warfare Pub 62, LCC 19/20 Tactical Manual

Books

Bellamy, Christopher, The Evolution of Modern Land Warfare: Theory and Practice, (London: Routledge, 1990).

Campen, Alan, D. ed., The First Information War, (Fairfax, VA: AFCEA International Press 1992).

Cohen, Eliot A. and John Gooch, Military Misfortunes: The Anatomy of Failure in War, (New York: The Free Press, 1990).

Cushman, John H., Thoughts for Joint Commanders, (Annapolis, MD: 1993).

Deighton, Len, Blitzkreig, (New York: Ballantine Books, 1982).

Gansler, Jacques, Affording Defense, (Cambridge, MA: MIT Press, 1989).

Hagerman, Edward, The American Civil War and the Origins of Modern Warfare, (Bloomington: Indiana University Press, 1988).

Hughes, Wayne P. ed., Military Modeling, (Alexandria VA: Military Operations Research Society, 1984).

Hughes, Wayne P., "C2 within the Framework of the Theory of Combat", in Proceedings of the 92 Symposium on Command and Control Research, (McLean VA: SAIC, 1992).

Inglis, Andrew F., Electronic Communications Handbook, (New York: McGraw-Hill, 1988).

Kinsley, Michael E., Outer Space and Inner Sanctums: Government, Business, and Satellite Communications, (New York: John Wiley and Sons, 1977).

Libicki, Martin C., The Mesh and the Net: Speculations on Armed Conflict in a Time of Free Silicon, (Washington D.C.: National Defense University, 1994).

Lubar, Steven, InfoCulture: The Smithsonian Book of Information Age Inventions, (Boston: Houghton Mifflin Co, 1993).

Martin, Donald H., Communications Satellites: 1958-1992, (El Segundo: The Aerospace Corporation, 1991).

McKenzie, E. C., 14,000 Quips and Quotes, (New York: Avenel, 1980).

McKnight, Clarence E., ed., Control of Joint Forces: A New Perspective, (Fairfax, VA: AFCEA International Press, 1989).

Orr, George, E., Combat Operations C3I: Fundamentals and Interactions, (Maxwell Air Force Base, AL: Air University Press, 1983).

Rice, M. A. and Sammes, A. J., Communications and Information Systems for Command and Control, (London: Brassey's, 1989).

Rienzi, Thomas Matthew, MG, USA, Vietnam Studies: Communications-Electronics, 1962-1970, (Washington D.C.: Department of the Army, 1972).

Scales, Robert E., BG, USA, Certain Victory: the US Army in the Gulf War, (Washington D.C.: Department of the Army, 1993).

Stewart, Richard W., Staff Operations: The X Corps in Korea, December 1950, (Ft. Leavenworth: USACGSC, 1991).

Summers, Harry G. Jr., On Strategy II: A Critical Analysis of the Gulf War, (New York: Dell Publishing, 1992).

Swain, Richard M., "Lucky War:" Third Army in Desert Storm, (Ft. Leavenworth, KS: U.S. Army Command and General Staff Press, 1994).

Thompson, G. R. and Harris, Dixie R., The Signal Corps: The Outcome, (Washington D.C.: Office of the Chief of Military History, 1966).

Toffler, Alvin and Heidi, War and Anti-War, (Boston, MA: Little, Brown and Company, 1993).

Tzu, Sun, The Art of War, Samuel B. Griffin, ed., (London: Oxford University Press, 1963).

Van Creveld, Martin, Command in War, (Cambridge, MA: Harvard University Press, 1985).

Weigley, Russell F., History of the United States Army, (New York: MacMillan Publishing, 1967).

Other

Briefing. "Force XXI Campaign Plan." Army Chief of Staff GEN Gordon R. Sullivan. To students at the Army Command and General Staff College, Ft. Leavenworth, Spring, 1994.

Hayes, John L., LtCol. Deputy J6, JTF 190, during Operation Restore Democracy. Telephone interview on 19 April 1995.

______. Electronic mail replies to specific questions, 1 May and 4 May 1995, transcripts available from the author.

Prantl, Carl, MAJ. S-3, 22nd Signal Brigade. Electronic mail replies to specific questions, 17 April 1995, transcripts available from the author.

Telephone interview with a Department of the Army representative knowledgeable about Signal Corps force structure, April 1995.

U.S. Army Information Systems Command. Facsimile: organizational chart of the 11th Signal Brigade. (Ft. Huachuca: USAISC, Combat Support Branch, 15 May 1995.

ENDNOTES

1. Sun Tzu, The Art of War, Samuel B. Griffin, ed., (London: Oxford University Press, 1963), p. 90.

2. For organizational change, see Napoleon's *corps de armee*, as described in Robert M. Epstein's "Patterns of Change and continuity in Nineteenth-Century Warfare," in The Journal of Military History, (Lexington: Society for Military History, 1992), Vol. 56, No. 3, pp. 376-377; for technology's impact, see Guderian's *blitzkreig*, as described in Len Deighton's Blitzkreig, (New York: Ballantine Books, 1982), especially p. 119.

3. James A. Hazlett and Martin C. Libicki, "Do We Need an Information Corps?" in Joint Force Quarterly, (Autumn 1993, No. 2), p. 89.

4. For a discussion of Force XXI and "information dominance," see Force XXI . . . America's Army of the 21st Century, (Washington D.C.: Office of the Chief of Staff Army, 1995); "information operations" and "information warfare" are defined in TRADOC Pamphlet 525-5, Force XXI Operations, August 1994; Toffler coined the term "Third Wave" in his book, Powershift, (New York: Bantam Books, 1990) where he discussed the increasing importance of information over previous "waves" of agrarian and industrial change. Toffler's War and Anti-war, (Boston: Little, Brown and Company, 1993) describes "Third Wave War" in pp. 63-81.

5. Formed in January 1994, the Army Digitization Office, however, does not fall under the Signal Corps' purview. This office, headed by a major general on the Headquarters, Department of the Army (HQDA) staff, is described in "Digitizing Force XXI: A Team Effort," in Army, February 1995, pp. 36-44. For another perspective on the complexity of this $8 billion, long-term effort, see Vincent P. Grimes' article, "U.S. Army Begins Digitization Build-up," International Defense Review, (Volume No. 27, August 1994), pp. 51-55.

6. For example, in Honduras, tactical equipment, intended for short-term use, was unable to handle subsequent high capacity requirements for strategic connectivity. Using commercial equipment when going into environments with austere or primitive communications infrastructure, as in Somalia, helps bridge the gap between tactical and strategic and simplifies the process of leaving the equipment in place after the mission is accomplished. See comments by USAISC Commander, MG Samuel Leffler, in John Roos, "InfoTech InfoPower," Armed Forces Journal International, (Volume 131, No. 11, June 1994), p. 32.

7. Tactical signal units at corps and division echelons look to Ft. Gordon for guidance, while strategic units, providing fixed and base-level services, belong to USAISC. In turn, Ft. Gordon falls under the Army's Training and Doctrine Command (TRADOC), while USAISC, as a major command of the Army, falls directly under the Chief of Staff of the Army. While the commander of Ft. Gordon is head of the Signal Regiment and Chief of Signal, his peer at USAISC, also a major general, has an equal voice. HQDA does not have a Signal Officer, thus, the Chief of Staff has no formal organizational control of Signal Corps decisions.

8. For a concise and non-technical description of MSE, read Chris Bellamy's The Future of Land Warfare, (New York: St. Martin's Press, 1987), pp. 251-253. Recently, JTF 190 in Haiti had difficulties extending MSE connectivity to the Defense Communications Systems entry point at Ft. Detrick.

9. With Milstar, this link could conceivably circumnavigate the globe in space, as cross-talking satellites relay the message 'around the world' without need of any ground-based relay. A quick overview of Milstar can be found in Roos, pp. 32-33. Typical bandwidth of a fiber optic cable is on the order of 1 GHz. Compare this with most satellite transponders or microwave links, which are on the order of 1 MHZ. Andrew F. Inglis, Electronic Communications Handbook, (New York: McGraw Hill, 1988), p 8.4. For a less technical discussion, see Bellamy, pp. 250-251.

10. Martin C. Libicki, The Mesh and the Net: Speculations on Armed Conflict in a Time of Free Silicon, (Washington D.C.: National Defense University, 1994), p. 7.

11. M. A. Rice and A. J. Sammes, Communications and Information Systems for Battlefield Command and Control, (London: Brassey's, 1989) gives a comprehensive description of the application of communications and information systems (CIS) technologies to military purposes. See also Roos, for a more specifically U.S. perspective.

12. FM 100-5, Operations, (Washington D.C.: Department of the Army, 1993), p. 1-3.

13. Ibid, p. 6-2.

14. Ibid.

15. See Chairman, Joint Chiefs of Staff Memorandum of Policy (MOP) 3, "CJCS-controlled Tactical Communications Assets," (Washington D.C.: CJCS, 1990), for specifics on units, assets and procedures for supporting JTFs.

16. FM 100-16 Army Operational Support Final Approved Draft, (Washington, D.C.: Department of the Army, February 1995), p. 8-2.

17. JCSE C4 Planner's Guide, (MacDill AFB, FL: JCSE, 1994).

18. The latest "Atlantic Resolve", a joint and combined exercise that simulates previous Return of Forces to Germany (REFORGER), tested V Corps' performance as a JTF.

19. See Richard Swain's "Lucky War:" Third Army in Desert Storm, (Ft. Leavenworth: USACGSC Press, 1994), especially Chapters 5, 6 and 7. Also see BG Robert Scales' official history, Certain Victory: The U.S. Army in the Gulf War, (Washington D.C.: Department of the Army, 1993), Chapter 5, "The Great Wheel."

20. MG Thomas M. Rienzi, USA, Vietnam Studies: Communications-Electronics 1962-1970, (Washington D.C.: Department of the Army, 1972), p. v.

21. Kathy R. Coker and Carol E. Stokes, A Concise History of the Signal Corps, (Ft. Gordon: Office of the Command Historian, USASC&FG, 1991), p. 8.

22. See Dr. James J. Schneider's, "Vulcan's Anvil: The American Civil War and the Emergence of Operational Art," (Ft. Leavenworth: School of Advanced Military Studies, USACGSC, 1991), especially pp. 35-37.

23. Actually, Alfred Vail's version is the one we call Morse Code. See Steven Lubar's Infoculture: The Smithsonian Book of Information Age Inventions, (Boston: Houghton Mifflin Co., 1993) for a readable summary of information technology's history.

24. Edward Hagerman, The American Civil War and the Origins of Modern Warfare, (Bloomington: Indiana University Press, 1988), pp. 40-44.

25. Coker and Stokes, p. 9.

26. Ibid.

27. Grant restored him to that office in July of 1866. Coker and Stokes, p. 58.

28. Hagerman, pp. 43-44.

29. G. R. Thompson and Dixie R. Harris, The Signal Corps: The Outcome, (Washington D.C.: Office of the Chief of Military History, 1966), pp. 13-15. Also, Coker and Stokes, pp. 16-22.

30. Coker and Stokes, pp. 16-19.

31. Deighton, p. 119.

32. Coker and Stokes, p. 22. Women from the Women's Army Corps (WACs) served as switchboard and in some cases, radio operators, occasionally overseas. Thompson and Harris, p. 28.

33. Coker and Stokes, p. 23.

34. Not that wire communications weren't prevalent. To the contrary, nearly a million miles of cable and wire were laid in the European Theater of Operations (ETO) alone by signaleers. Thompson and Harris, p. 172.

35. Coker and Stokes, p. 22. Also Thompson and Harris, pp. 21-22, 119-121, and 124.

36. Coker and Stokes, p. 14.

37. Thompson and Harris, pp. 580-585, and 620-623. Descendants of this network are connected through fixed facilities manned and operated by strategic communications units currently controlled by USAISC. They perform important peace-time and war-time functions. Much of the circuitry linking them is now commercially leased. Department of the Army, Signal Bulletin, (Washington, D.C.: Signal Branch, Personnel Command, 1994), pp. 49-53 lists 19 Information Mission Area or Strategic Signal Battalions.

38. Richard Stewart, Staff Operations: the X Corps in Korea, (Ft. Leavenworth: USACGSC, 1991), p.53.

39. Rienzi, pp. 18-20.

40. Coker and Stokes, p. 4. Also, Rienzi, pp. 8-11.

41. Rienzi, p. 114.

42. Martin van Creveld, Command in War, (Cambridge: Harvard University Press, 1985), p. 258. His description of "information pathology" also bears study.

43. Rienzi, pp. 134-135. This figure includes an estimate of manual, semi-automatic and automatic switching loads. It also includes 42,000 Military Affiliated Radio System (MARS) telephone patches from Vietnam to the U.S. for morale support purposes.

44. Van Creveld, pp. 255-256.

45. Ibid.

46. Also known as Field Forces early in the war. See Rienzi, p. 60.

47. Ibid, p. 154.

48. In wartime, OPLAN 5027 calls for the creation of a signal command as the parent signal headquarters.

49. In 1989, the Signal Corps became the third largest branch in the Army and had 114 battalions and 22 brigades. Coker and Stokes, p. 116. The 93rd Signal Brigade was formed in Germany to support VII Corps in 1980.

50. Martin van Creveld, Technology in War, (London: 1991), p. 38.

51. Harry G. Summers, Jr., On Strategy II: A Critical Analysis of the Gulf War, (New York: Dell Publishing, 1992), p. 157.

52. Swain, p. 354.

53. Headquarters, VII Corps, "Desert Campaign After Action Report," (Volume 21a, 93rd Signal Brigade, undated). Not only is Saudi Arabia larger than Germany, it also has very few hill masses suitable for long-range radio transmission sites, so range is often limited by curvature of the earth.

54. Ibid, COL Richard Walsh's, executive summary, p. 2.

55. From the author's own experiences in 1981-1986, the 93rd had habitual training experience with the 7th Signal Brigade as the theater signal organization in Europe. Though the 7th and 11th shared common Standard Operating Procedures (SOPs), interfacing with different organizations is not always a simple matter.

56. A contract was let in 1985 to procure this system for the entire Army, active and reserve. It was based on the French RITA system and was intended to equip 5 corps and 25 divisions. Coker and Stokes, pp. 29-32.

57. See MAJ Lorenzo A. Goins, "What the Heck is STANAG: Solving the Interoperability Puzzle," Army Communicator, (Volume 17, No. 1, Spring 1992), p. 3.

58. Larry K. Wentz, "Communications Support for the High-Technology Battlefield," in First Information War, Alan D. Campen, ed., (Fairfax: AFCEA International Press, 1992), pp. 7-22. This standard also specifies connections with German and French equipment.

59. "Desert Campaign AAR," p. 4. MSE information is from Bellamy.

60. "Desert Campaign AAR," p. 6. See also Joseph Toma's, "Desert Storm Communications," in First Information War, Alan D. Campen, ed., (Fairfax: AFCEA International Press, 1992), pp. 2-5.

61. Department of Defense, Final Report to Congress: Conduct of the Persian Gulf War, (Washington D.C.: Government Printing Office, 1992), Appendix K, p. 559.

62. Ibid, p. 562 and 564-565. By 28 November, all 160 UHF FLTSATCOM channels were saturated. Also, "Desert Campaign AAR,", p. 6.

63. Ibid, p. 566.

64. "Desert Campaign AAR," p. 6.

65. Jean Slupik, "Integrating Tactical and Strategic Switching," in First Information War, Alan D. Campen, ed., (Fairfax: AFCEA International Press, 1992), pp. 143-148.

66. Conduct of the Persian Gulf War, p. 564.

67. Like two experimental multiple access communications satellites (MACSAT), which employed store and forward techniques to support logistics information dissemination. Sir Peter Anson and Dennis Cummings, "The First Space War," in The First Information War, Alan D. Campen, ed., (Fairfax: AFCEA International Press, 1992), p. 123.

68. Conduct of the Persian Gulf War, p. 572.

69. This integrated systems control is a pre-planned product improvement (P3I) for the MSE system. See Clarence A. Robinson, Jr., "Critical Link Consolidates Army's Tactical Networks," in Signal, (Volume 49, No. 7, March 1995), pp. 24-27 for current information.

70. Conduct of the Persian Gulf War, p. 570.

71. Wentz, p. 15.

72. Ibid, p. 21.

73. Both the 1st Cavalry Division and 3rd Armored Division commanders extolled their MSE-equipped battalions, which provided them excellent internal communications, but which were much more mobile than the TRI-TAC and IATACS-equipped 93rd. Conduct of the Persian Gulf War, p. 566.

74. The author participated directly in numerous training exercises in Germany with the 93rd from 1981-1987, including time as commander of a corps command radio company and an area signal company. Nodes very rarely displaced.

75. To be fair, communications doctrine has often identified the single channel FM radio, Guderian's C2 weapon of choice in *Blitzkreig*, as the mainstay of offensive operations. FM 24-1 Combat Communications, (Washington D.C.: Government Printing Office, 1985), p. 5-8, for contemporary doctrine.

76. Saudi Arabia, for example, bought SINCGARS in 1993. John D. Williamson, "Keeping all in contact (sic)," in Jane's Defence Weekly, (Volume 21, No. 9, 5 March 1994), p. 21.

77. General information comes from two sources. First, LtCol John Hayes, USAF, who was Deputy J6, JTF 190, with whom the author worked at J6 United States Space Command from 1990-1993, granted a telephone interview and subsequently answered specific questions via electronic mail from 19 April to 4 May 1995. Transcripts of the electronic mail are available from the author. Second, MAJ Robert S. Ferrell, "Operation Uphold Democracy," Signal, (Volume 20, No. 1, Winter 1995), pp. 7-14, describes the 35th Signal Brigade structure at Ft. Bragg and 82nd Signal Battalion's plans for the combat operation.

78. FM 100-16, p. 8-6.

79. Ibid, p. 8-10. Also, Ferrell, pp. 10-11.

80. Electronic mail message from LtCol Hayes, 19 April 1995.

81. Captain Richard Sharpe, RN, Jane's Fighting Ships, (Coulsdon: Jane's Information Group, 1993), p. 762 describes these amphibious command ships, designated LCCs 19 and 20. Edward J. Walsh, "Navy Drives Development for Joint Command-Control Vision," Seapower, (Volume 37, No. 8. August 1994), pp. 25-26, describes Navy C2 systems for ship to shore and joint operations.

82. For JTF 180 information, Ferrell, p. 8. For JTF 190 data, electronic mail message from LtCol Hayes, 19 April 1995.

83. Electronic mail message from LtCol Hayes, 1 May 95. Frequency management and the prevention of RF interference is a major task. See Earl Takeguchi and William J. Wooley, "Spectrum Management," in The First Information War, Alan D. Campen, ed., (Fairfax: AFCEA International Press, 1992), pp. 155-160.

84. Ferrell, pp. 9-10. Also, electronic mail message from LtCol Hayes, 1 May 1995. For INMARSAT and INTELSAT communications, see Gary M Comparetto "The Use of INTELSAT and INMARSAT to support DOD Communications Requirements," (Colorado Springs: U.S. Army Space Command, 1993). The Navy is installing DSCS terminals on capital ships, per a briefing by Naval Space Command, as presented to the School of Advanced Military Studies in April 1995.

85. Ferrell, p. 9.

86. Electronic mail message from LtCol Hayes, 1 May 1995.

87. Ibid. A T-1 (or DS-1) is 1.544 Mbps, a commercial standard digital carrier: this bandwidth equates to roughly 50 high-quality voice circuits operating simultaneously. A typical MSE channel, by comparison, is 16 Kbps, or about 1% of a T-1. Inglis, pp. 7.8-7.12.

88. Electronic mail message from LtCol Hayes, 1 May 1995. The constellation was so healthy that even Vigilant Warrior, the October 1994 "return to Kuwait" took away none of this bandwidth.

89. Electronic mail message from LtCol Hayes, 4 May 1995. It must be noted here that the space order of battle for communications satellites orbiting over the east coast of the U.S. provides a fairly robust amount of SATCOM for force projection operations in the Caribbean, as compared to that for a Middle Eastern scenario. See U.S Army Space Reference Text, (Ft. Leavenworth: U.S. Army Space Institute, July 1993). While 35th Signal Brigade has eight TSC-93s, when the combat operations were called off, much of the communications to support JTF 180 returned to Ft. Bragg and reverted to reserve status for combat contingencies. The 35th also installed terminals at Ft. Bragg to link the JTF with its support base. Ferrell, p. 9. The 11th's and the Air Force terminal assets were requested per CJCS MOP 3.

90. Electronic mail message from LtCol Hayes, 4 May 1995.

91. Ibid.

92. Ibid. Morale calls in Desert Shield/Storm were restricted to certain hours, based on traffic loading and circuit availability. See Alan Campen, "Information Systems and Air Warfare," in The First Information War, pp. 31-32.

93. Message from LtCol Hayes, 1 May 1995.

94. Ibid. For an excellent description of the issues of security in distributed information systems, see Rice and Sammes, pp. 193-216.

95. This is a one-of-a-kind satellite. For a brief description, see Donald H. Martin, Communications Satellites, (El Segundo: The Aerospace Corporation, 1991), pp. 41-45. Imagery and tele-medicine require high bandwidth. ACTS can provide T-1 switched satellite service. For a discussion with tactical application, see Robert K. Ackerman, "Low-Cost Imagery Processing Reaches Echelons Below Corps," Signal, (Volume 49, No. 7, March 1995), pp. 47-49.

96. Electronic mail message from LtCol Hayes, 4 May 1995. He was the Milstar action officer on USSPACECOM's J6 staff from 1990-1993 and is one of DOD's experts on this system. Also, see U.S. Army Space Reference Text, pp. 7-24 to 7-26.

97. Ferrell, p. 11. Hand-held radios, cellular telephones with small base stations, and pagers are all particularly useful, especially in urban environments with unreliable or non-existent commercial communications networks. Mobility and security are both important. Immediate access to personal communications devices is a fact of modern life; military communications units should have these in ample supply.

98. Electronic mail message from LtCol Hayes, 1 May 1995.

99. Anson and Cummings, p. 127.

100. Rice, p. 231. By his analysis, now a few years old, a typically computer literate officer today would be a junior Lieutenant Colonel. In 1995, the author finds many senior officers with exceptional grasp of information technology.

101. LTG John H. Cushman, (ret), "Make it Joint Force XXI," Military Review, (March/April 1995), pp. 4-9. See also his book, Thoughts for Joint Commanders, (Annapolis: published by the author, 1993), distributed to students of the School of Advanced Military Studies, summer 1994.

102. Eliot A. Cohen and John Gooch, Military Misfortunes, (New York: The Free Press, 1990), p. 239.

103. Ibid, p. 125.

104. Joint Pub 1 Joint Warfare of the U.S. Armed Forces, (Washington D.C.: Office of the Chairman, JCS, 1991), p. iii.

105. This information comes from various sources. Air Force Theater Deployable Communications Program Roadmap, Department of the Air Force, 1993, identifies the supporting communications unit for each numbered Air Force and Wing. FM 11-45 and FM 11-30 describe Army communications brigades and battalions that support echelons above corps and the corps and division, respectively. Fleet Marine Force Organization, FMFRP 1-11, (Washington D.C.: Department of the Navy, 1992), pp. 6-3 and 7-2, identifies Marine communications units: SRIG stands for Surveillance, Reconnaissance, and Intelligence Group, and FSSG is Force Service Support Group.

106. These amphibious warfare command and control ships, refitted with impressive suites of communications gear, are LCCs 19 and 20. See Jane's Fighting Ships, (Couldson: Jane's Information Group, 1994), p. 762.

107. Air Force Theater Deployable Communications Program Roadmap, pp. 29-41.

108. Joint Pub 6-0 Doctrine for Command, Control, Communications, and Computer Support to Joint Operations, (Washington D.C.: Office of the Chairman, JCS, 1992), p. I-4.

109. FM 11-45 Signal Support: Echelons Above Corps, (Washington D.C.: Department of the Army, September, 1992), p. 2-2.

110. Chairman, Joint Chiefs of Staff (CJCS) Memorandum of Policy No. 3 (MOP 3), "CJCS-controlled Tactical Communications Assets," (Washington D.C.: CJCS, 31 January 1990), p. 2.

111. 11th Signal Brigade Organization Chart, facsimile, USAISC, Combat Support Branch, Ft. Huachuca, 15 May 1995.

112. CJCS MOP 3, p. B-4. Specific taskings to the 11th fall under the title: Defense Communications System Central Area (DCS-CA). Other 11th items are identified as Army CJCS-controlled assets, p. B-3.

113. The JCSE mission statement is found in Military Commission Memorandum (MCM) 149-93, "CJCS-controlled JTF Communications Capabilities," 29 October 1993.

114. Conduct of the Persian Gulf War, p. 573.

115. CJCS MOP 3, p. 2.

116. Ibid, pp. 2-6. These procedures are also explained in the JCSE C4 Planner's Guide.

117. CJCS MOP 3, Appendix B, pp. B-1 to B-5.

118. WWMCCS is not designed to interface with tactical systems. See Joint Pub 6-0, p. VI-3.

119. Telephonic interview and electronic mail messages with 22nd Signal Brigade Operations Officer, MAJ Carl Prantl, in March/April 1995, transcripts available from the author.

120. E.C. McKenzie, 14,000 Quips and Quotes, (New York: Avenel, 1980), p. 179.

121. Hazlett and Libicki, especially pp. 96-97.

122. Telephonic interview with a Department of the Army official knowledgeable about signal force structure issues, April 1995. This source indicated that the Army's Director for Information Systems, Command, Control, Communications and Computers (DISC4) is studying this issue in accordance with a Deputy Chief of Staff Operations, Force Development, request.

123. E.C. McKenzie, p. 242.

124. From Army Chief of Staff GEN Gordon Sullivan's briefing on the Force XXI Campaign Plan, given to CGSC students in the Mobile Strike Force Battle Command Elective in spring 1994 at Ft. Leavenworth.